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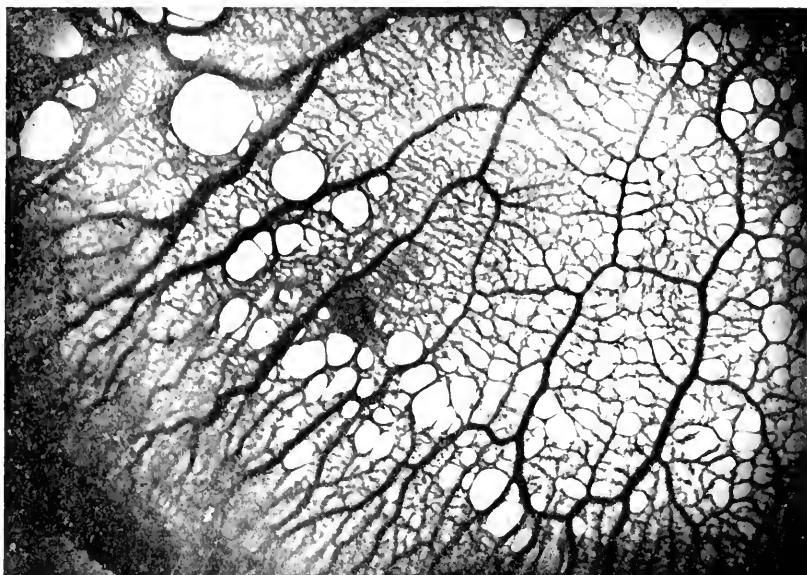




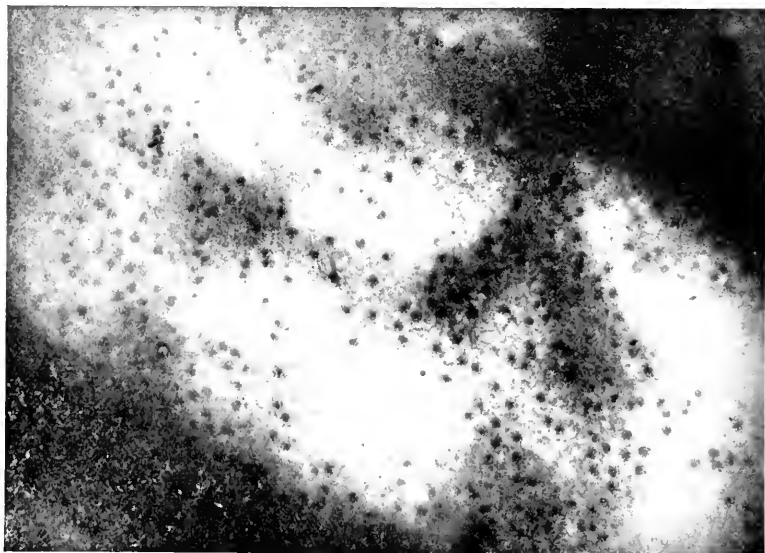
# MYCETOZOA







*BADHAMIA UTRICULARIS* Berk.  
Plasmodium spreading on glass, magnified 15 times.



Part of the same, showing nuclei, magnified 400 times.

not  
alloph

British Museum (Nat. Hist.). *Mycetozoa*

A MONOGRAPH  
OF THE  
MYCETOZOA

A DESCRIPTIVE CATALOGUE

OF THE SPECIES IN THE  
HERBARIUM OF THE BRITISH MUSEUM

BY  
ARTHUR LISTER, F.R.S., F.L.S.

SECOND EDITION, REVISED  
BY  
GULIELMA LISTER, F.L.S.

WITH TWO HUNDRED AND ONE PLATES  
AND FIFTY-SIX WOODCUTS

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## PREFACE TO SECOND EDITION.

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THE widespread interest aroused in the study of the Mycetozoa by the publication of Mr. Lister's work has found expression in a large influx of material, the study of which has led to the recognition of new genera and species, and an extension of our knowledge of the geographical distribution of known forms; and has in some instances rendered necessary a re-consideration of views previously held. These considerations, together with the revision of the nomenclature in conformity with the International Rules, practically necessitated re-writing the book when the need arose for a new edition. In the preparation of this edition Miss Lister has continued the work in which she was for so long and so intimately associated with her father, and for which she is so eminently well equipped.

A special feature of the second edition is the replacement of the collotype plates by a new and more complete series. A large proportion have been reproduced by the three-colour process, and greater justice has thus been done to the original drawings by Mr. and Miss Lister, than was possible by the method of reproduction formerly employed; that so large a proportion are reproduced in colour is due to Miss Lister's generosity. A bibliography has been added, and also a short glossary which supplements the explanation of terms given in the Introduction.

In order to make the National Collection as complete as possible, Miss Lister is generously presenting a large series of specimens to the Museum.

A. B. RENDLE.

DEPARTMENT OF BOTANY,

*November, 1911.*

## PREFACE TO FIRST EDITION.

---

THE collection of specimens of Mycetozoa in the Herbarium of the British Museum has been greatly increased in recent years. The additions include the large collection of the late C. E. Broome, bequeathed by him to the Museum, and that of H. W. Ravenel, purchased from his widow.

It was necessary to make a critical examination of the whole of the materials in the Herbarium. Mr. Arthur Lister, who has devoted much attention to these organisms, was fortunately able to undertake this work; and he agreed at the same time to prepare a monograph of the whole class based on this examination.

This volume, the result of his labours, contains descriptions not only from the specimens in the Museum, but also from types in various public and private Herbaria, and from his own rich collection. Mr. Lister has generously presented a large series of specimens to the Museum, so that the Herbarium now contains types of all the species described by him in this monograph.

The volume is fully illustrated with plates mechanically reproduced from faithful water-colour drawings by the author and by his accomplished daughter, to whom in the Introduction Mr. Lister acknowledges his obligations.

WILLIAM CARRUTHERS.

*November, 1894.*



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## NOTE TO SECOND EDITION

It was my father's intention to have brought out the second edition of this Catalogue himself, and the book in its present form has been largely compiled from material collected by him. In the many alterations now introduced, his views have been for the most part embodied.

I had the privilege of being associated with him both in the preparation of the first edition and in the work undertaken in anticipation of the second. In bringing this edition to completion since his death in 1908, I have endeavoured to follow the conclusions arrived at in discussing with him the different points as they arose.

In the first edition of the present work the custom was followed, by which the first authentic specific name published under the genus in which the species now stands takes precedence of all others. When the Rules of Nomenclature were revised in 1905, it was agreed to follow in this respect the "Laws of Botanical Nomenclature," drawn up by Alphonse de Candolle in 1867, namely, to adopt the earliest specific name under whatever genus it may have been published; and at the recent International Botanical Congress at Brussels (1910) it was decided that the starting point for these names, as well as for those of the genera of *Mycetozoa*, should be the "Species Plantarum" of Linnaeus, published in 1753. This principle was observed by Prof. T. H. Macbride in the compilation of his "Slime-Moulds of North America," and the results of his researches, and moreover, his friendly correspondence, have been of much assistance to me in making the numerous changes in familiar names in the present edition of the British Museum Catalogue necessitated by the adoption of a new rule of nomenclature. I have traced the history of the species in the library of the Department of Botany at the Museum, a task which in the former edition was kindly undertaken by Mr. Carruthers, who was then at the head of the Department. I cannot be too grateful to Dr. Rendle and the present staff of the department for their unfailing kindness and courtesy in facilitating the labour involved in this part of the work.

In the introduction to the first edition my father expressed his thanks to those from whom he had received assistance, and I here quote his own words : " I offer my grateful acknowledgments to those through whose courtesy I have been enabled to study the various herbarium specimens that have come under my notice ; to the Director of the Royal Gardens at Kew for giving me special facilities for investigating the collection under his care, which includes Berkeley's precious series, containing a great number of original types from India, New Zealand, and America, that supplied Rostafinski with a large part of the material introduced into the Appendix to his Monograph. These types are to a large extent duplicated in Broome's and Ravenel's collections in the British Museum. To Professor Bayley Balfour I return my thanks for much friendly assistance and for the opportunity of inspecting the specimens in the Royal Herbarium at Edinburgh, including Greville's collection and an almost complete set of type examples supplied by the late Professor de Bary ; to Professor van Tieghem for the inspection of the collection of the Paris Museum ; to Professor A. Blytt for an opportunity of examining the most important types in the Museum at Christiania ; to Dr. Boerlage for giving me access to the Leyden collections ; and especially to Graf zu Solms-Laubach for the privilege afforded me of inspecting de Bary's invaluable collection at Strassburg, containing a large proportion of the type specimens referred to by Rostafinski in his original Monograph ; to Dr. Rex, of Philadelphia, for a nearly complete series of the species found in the United States of America, now represented in the British Museum collection, and for the communication of his views on a group to which he has devoted many years of careful research. I am also grateful to my friend Professor Farlow for many valuable specimens and useful suggestions ; and to Professor Macbride, of Iowa, and Mr. Morgan, of Ohio, for a fine series of the *Mycetozoa* from their respective districts ; also to Dr. Haviland for specimens of great interest from Borneo. Mr. Camm, of Smethwick, and Mr. Saunders, of Luton, have supplied me with many scarce British species ; and to Mr. Phillips and Mr. Massee I am obliged for kindly entrusting me with their collections for examination."

I should like to add my grateful thanks to those who, since the publication of the first edition, have greatly assisted both my father and myself by sending us specimens, as well as by their correspondence.

Dr. W. C. Sturgis, of Colorado Springs, has, for fourteen years, been a fellow-worker on whose friendly co-operation we could always depend ; Dr. Jahn, of Berlin, has generously placed the results of his work on the life history of the group

at our disposal. In studying the distribution of the different species we have been greatly indebted to the collections made by the Rev. W. Cran and also by Professor Raunkiaer in the West Indies, by Dr. R. E. Fries in Sweden and Bolivia, by Professor Penzig in Java, and by Mr. Hugo Bilgram in Pennsylvania. The observations of our friend Mr. Petch on the *Mycetozoa* of Ceylon have been of great value, and our knowledge of those of Japan has been much increased by the unwearied labours and graphic correspondence of Mr. K. Minakata, from whom we have received nearly three hundred specimens. The numerous gatherings made by Dr. C. Torrend in Portugal are the first examples of this group recorded from that country and have been kindly sent us for inspection. Dr. Čelakovsky has presented us with a valuable collection of his Bohemian gatherings; we have also had the advantage of receiving many Swiss specimens from our friend Professor Hans Schinz, of Zürich, and, recently, from M. Meylan from the Jura Mountains. There are many others whose names I have not mentioned to whose contributions we have been greatly indebted.

I should like to repeat on my own account the acknowledgment given above to Professor Farlow for his continued assistance and sympathy, and to Mr. James Saunders for his constant assiduity not only in reporting his own investigations but in arousing the interest of others in the subject.

I cannot close without saying how invaluable it has been to me to have the counsel and experience of my brother Mr. J. J. Lister to rely on in continuing our father's work.

The plates at the end of the volume are reproductions of water-colour drawings made under the camera lucida by my father and myself, and are here reduced to half the diameter of the originals.

G. LISTER.

## INTRODUCTION

FRIES gave the name of *Myxogastres*, in 1829, to the group of organisms described in this Monograph, placing it among the Gasteromycetous Fungi. In 1833 Wallroth substituted the term *Myxomycetes* (Schleimpilze) for the older name, and this came to be the generally accepted designation. Later investigations showed that the spores, instead of producing a mycelium, as in the case of fungi, give birth to *swarm-cells*, which coalesce to form a *plasmodium*. In consequence of this discovery, which indicated a relationship with the lower forms of animal life, de Bary in 1858 introduced the name *Mycetozoa*.

Under the head of *Mycetozoa*, de Bary still retained the term *Myxomycetes* for the section so named by Wallroth, but linked with it the *Acrasieae* of Van Tieghem (*Sorophora* Zopf), a small group inhabiting the excrement of animals. In these the spores produce swarm-cells, which multiply by division but do not pass through a flagellate stage or coalesce to form a plasmodium. At a certain period, when the fruits are about to be formed, the swarm-cells approach each other and adhere loosely in branching strings; they eventually concentrate at various points, becoming massed together in aggregations of more or less definite shape; the swarm-cells, however, do not lose their individuality. In *Dictyostelium* and some other genera of the *Acrasieae*, a stalk is formed by the arrangement of a number of individuals in vertical rows in the centre of the heap; the surrounding amoeboid bodies creep up this stalk and form a cluster at the extremity, where each amoeboid swarm-cell acquires a spore-wall; the spore-cluster is not enclosed by a definite sporangium-wall.

Rostafinski followed de Bary in the view that the formation of a plasmodium indicates a wide separation in the natural position of the *Myxomycetes* from the fungi, but he suppressed that name entirely, adopting de Bary's class name *Mycetozoa* in its place; at the same time, he admitted into his Monograph

*Dictyostelium*, a genus of the *Acrasieae*. The reason for his including this genus may be the fact, pointed out by de Bary, that Brefeld in first describing the dense aggregations of swarm-cells into the stalked spore-masses of *Dictyostelium*, refers to them as being "plasmodia, that is, products of the coalescence of swarm-cells"; and it was not until after the publication of Rostafinski's Monograph that Van Tieghem in 1880 and Brefeld in 1884 corrected this statement.

Accepting the *Mycetozoa* as established by Rostafinski, but excluding *Dictyostelium* on the ground of its not forming a true plasmodium, we have a clearly defined group of organisms separated from all others by the following combination of characters: A spore provided with a firm wall produces on germination an amoeboid swarm-cell which soon acquires a flagellum. The swarm-cells multiply by division and subsequently coalesce to form a plasmodium which exhibits a rhythmic streaming. The plasmodium gives rise to fruits which consist of supporting structures and spores. In the *Endosporeae* these take the form of sporangia, each having a wall within which the free spores are developed. A *capillitium* or system of threads forming a scaffolding among the spores is present in most genera. In the *Exosporeae* they consist of *sporophores* bearing numerous spores on their surface.

The fact referred to below that the swarm-cells ingest bacteria, appears to strengthen the view that the group is more nearly associated with the lower forms of animal than of vegetable life, and the name of *Mycetozoa* appears to mark its true position in the borderland between the two kingdoms.

*The Spore and Swarm-cell.*—The spores of the *Endosporeae* are mostly spherical, but occasionally they are ellipsoid. Their size is so uniform in each species that their measurement affords a valuable character for specific determination, though in a few cases (as in *Leocarpus fragilis* and some others) different gatherings vary considerably in the size of the spores. The spore-wall is variously coloured in the different species. It is described by Zopf as showing the chemical reaction of cellulose, and consisting of a simple firm membrane.\* The spores of several species of *Didymium* and *Trichia*, when crushed and stained, show the existence of two layers, the inner more delicate and appearing less deeply stained than the outer. In *Physarum*, *Arcyria*, and genera with thin-walled spores, an inner layer has not been traced. The spore-wall may be either smooth, warted or reticulated, and often shows a thinner area where dehiscence takes place. The contents of the spore consist of faintly granular protoplasm with a single central nucleus. In abnormal developments, monstrous

\* "Die Pilzthiere," p. 53, in Schenk "Handbuch der Botanik," iii. 2 (1884).

spores, often of irregular shape and containing several nuclei, are of frequent occurrence.

The spores while remaining in a dry state retain their vitality for several years. The length of time that elapses before the germination of the spore after it has been placed in water varies with the species, and often in different gatherings of the same species. Observations on the darker spores of *Stemonitis fusca* showed germination after nine or twelve hours, while in the pale-spored variety it occurred in twenty-eight minutes. In *Reticularia Lycoperdon* it usually takes place in less than an hour in fresh gatherings; spores from a specimen which had been stored for nearly three years began to germinate in four hours, and in twenty hours the contents

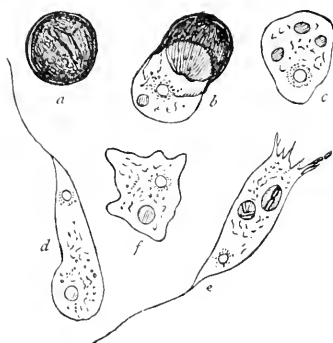


FIG. 1.—*DIDYMIUM DIFFORME* Duby.

- a. Spore.
- b. Swarm-cell escaping from the spore-case.
- c. Newly hatched swarm-cell containing a nucleus and three vacuoles.
- d. Flagellated swarm-cell.
- e. Swarm-cell, with two vacuoles containing bacteria, and produced at the posterior end into pseudopodia, to one of which a bacterium is attached.
- f. Amoeboid swarm-cell.

Magnified 720 times.

of nearly every spore had emerged. The spores of *Didymium difforme* that had been preserved three years and nine months, on being placed in water produced abundant swarm-cells in twenty-eight hours, and in a few days all the spores appeared to have germinated.

The spore-wall is ruptured by the swelling of the contents, which slowly emerge and lie as a nearly pellucid globule by the side of the empty spore-case.\* After remaining quiescent for a few minutes amoeboid movements begin to take place, and shortly afterwards a flagellum is produced. This is at first a somewhat tentative process, and the flagellum

is frequently withdrawn; but within a quarter of an hour it acquires its full length of about  $15\mu$ , and by its lashing strokes the swarm-cell swims off with a dancing movement. At this stage it is pyriform in shape, the interior body-substance is granular and contains a contractile vacuole, and often one or more vacuoles in addition which do not usually show contraction. At the narrow end is placed the nucleus, which can easily be recognised by its lighter and more homogeneous appearance and central nucleolus. The

\* Pinoy has shown that in the case of the *Sorophora* the presence of certain bacteria is necessary for the germination of the spores, and his experiments suggest that this may also be true of the *Mycetozoa* (Ann. Inst. Pasteur, xx. 627 & 688).



nucleus does not alter its position, though constant movement is observed among the constituents of the granular part. Connecting the nucleus with the base of the flagellum is a bell-shaped tract free from granules, which takes when stained a rather darker colour than the surrounding cytoplasm.\* The whole swarm-cell is enclosed by a layer of hyaloplasm of extreme tenuity over most of the surface, but thicker at the posterior end, where it often extends in a brush of two to eight more or less slender pseudopodia. In addition to the dancing motion, which is maintained as long as they are free in the water, the swarm-cells when they come to rest exhibit movements of an amoeboid character, and spread with an irregular outline; or they assume a linear form and creep over a level surface with a snail-like motion, the flagellum being extended in advance. In this position the movement of the interior substance is seen to advantage. In the large swarm-cells of *Amaurochaete fuliginosa* it may almost be described as streaming, the granules passing from one end to the other in constant flow. The hyaloplasmic extension at the posterior end continually changes its form and it is here that refuse matter is discharged. After a time the creeping movement is again exchanged for the dancing. In all cultivations of germinating spores, a number of the swarm-cells, after a short period of activity, withdraw the flagellum and become encysted in a globular form (the *microcysts* of Cienkowski). After being dried and re-wetted, the contents burst the membranous cyst-wall, which remains as an empty hyaline sac, and emerge to resume their activity. If bacteria are introduced into a cultivation of swarm-cells on the stage of the microscope, they are seen to be laid hold of by the pseudopodia and drawn into the interior of the swarm-cells, where they are enclosed in a digestive vacuole. Several bacteria are brought in turn to the same chamber, or fresh captures are conveyed into one or more additional vacuoles. The protrusion of pseudopodia

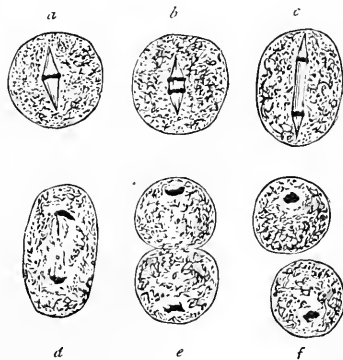


Fig. 2.—*AMAUROCHAETE FULIGINOSA* Macbr.

a to f. Successive stages in bipartition of swarm-cell, accompanied by the division of the nucleus by karyokinesis. Magnified 1200 times. Drawn from stained preparations in Canada balsam.

the dancing. In all cultivations of germinating spores, a number of the swarm-cells, after a short period of activity, withdraw the flagellum and become encysted in a globular form (the *microcysts* of Cienkowski). After being dried and re-wetted, the contents burst the membranous cyst-wall, which remains as an empty hyaline sac, and emerge to resume their activity. If bacteria are introduced into a cultivation of swarm-cells on the stage of the microscope, they are seen to be laid hold of by the pseudopodia and drawn into the interior of the swarm-cells, where they are enclosed in a digestive vacuole. Several bacteria are brought in turn to the same chamber, or fresh captures are conveyed into one or more additional vacuoles. The protrusion of pseudopodia

\* "Verbindungsstück" Plenge, "Geisselglocke" Jahn in Ber. Deutsch. Bot. Gesell., xxii. 86.

usually ceases for a time after such ingestion, and the hinder end of the swarm-cell takes a rounded form. In the course of an hour or two the bacteria are assimilated, and the digestive vacuoles disappear. Unicellular algae and inorganic matter are sometimes taken in, which are subsequently discharged. Both ingress and egress are observed to take place only at the posterior end.\* De Bary stated that swarm-cells derive their support only from nutrient matter in solution†, and it may be that they are to some extent nourished in this manner; but considering the large number of species belonging to different genera which have been observed to prey actively on bacteria, it cannot be doubted that these form an important part of their food.

Bipartition of the swarm-cells is observed to begin a few hours after they leave the spore-case, and is several times repeated in the course of the three or four succeeding days. The bipartition is preceded by the withdrawal of the flagellum and the swarm-cell taking a spherical form. The nucleus then divides by karyokinesis; the swarm-cell becomes ellipsoid and later a constriction appears in the middle. As bipartition proceeds the nuclear plate divides and the two halves separate, the connecting achromatic fibres being discernible. The daughter-nuclei at length retreat to the opposite poles of the swarm-cell, which in about a quarter of an hour from the beginning of the process of constriction is completely divided (fig. 2). A flagellum is in a short time produced by each daughter-cell, which then assumes the original form of the parent. Jahn has shown that the bell-shaped tract crowning the nucleus is formed again after mitosis from the spindle fibres of the dividing nucleus, and that the flagellum is produced from its apex (l.c., p. 89).

After dividing in the manner described, through a period of uncertain duration, the swarm-cells withdraw the flagellum,



FIG. 3.—*DIDYMIUM DIFFORME* Duby.

Young plasmodium, with converging amoeboid swarm-cells. A number of microcysts (*m*) were present in this preparation, one of which is being digested in a vacuole (*v*). An empty spore-shell is shown at *s*.

Magnified 470 times.

\* Lister, "On the Ingestion of Food Material by the Swarm-Cells of *Mycetozoa*," in *Journ. Linn. Soc. (Bot.)* XXV. 435 (1889).

† De Bary, "Comp. Morph. and Biol. Fungi, Mycetozoa, etc.," 452.

and creep with slow amoeboid movement. When two of them come in contact with each other they may coalesce; others congregate at this point and a centre is formed to which great numbers converge, and though they may remain distinct for some time, they ultimately unite and mingle into one moving mass, the *plasmodium* of Cienkowski (fig. 3). The young plasmodia appear to exercise a definitely attracting influence on the swarm-cells in their neighbourhood. Although the fusing swarm-cells thus lose their individuality, their nuclei, so far as has been observed, remain distinct. For example, eight swarm-cells were counted uniting and forming a plasmodium, and their eight nuclei could be afterwards distinguished; but when this number is exceeded the movements of the plasmodium and the inconspicuous nature of the nuclei present difficulties in the way of their recognition. Whatever reason there may be from general considerations to regard this fusion of individuals as akin to conjugation, no fusion of nuclei, which appears to be an essential part of that process, has yet been observed.

In the *Exosporeae*, represented by the single genus *Ceratiomyxa*, the mature spore is ellipsoid, and consists of granular protoplasm containing four nuclei; it is enclosed by a membranous and colourless spore-wall. On placing the spores in rain water, the membranous wall is seen almost immediately to slip free from the protoplasmic contents, often with a sudden jerk, and by this action may be removed to some distance from the now naked spore, while it retains its original form as an empty transparent sac. The naked spore remains from

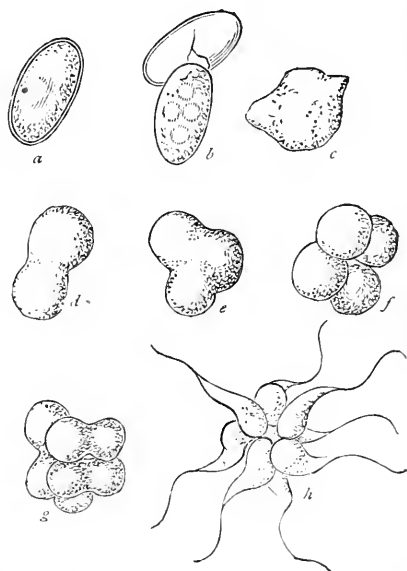


FIG. 4.—*CERATIOMYXA FRUTICULOSA* Macbr.

- a. Spore.
  - b. Spore-contents escaping from the spore-wall.
  - c. to g. Successive stages in the division of the naked spore to eight.
  - h. Cluster of eight swarm-cells.
- Magnified 1200 times.

six to nine hours without any apparent alteration; at the end of this time a slow amoeboid change of outline is observed, sometimes accompanied by the projection of numerous pointed pseudopodia. The four nuclei now divide by karyokinesis. A constriction appears in the middle portion of the cell, followed by a second constriction in each half. The first division may now become complete, but usually the whole of the spore contents remain united until a further constriction takes place in each quarter, and in about an hour from the time when the first movement was observed the originally ellipsoid body is divided into eight spherical portions, each containing a nucleus. These portions occasionally become free at this stage, but as a rule they continue attached to one another by narrow bridges; a few minutes later each protrudes a flagellum and assumes the pyriform figure of a swarm-cell; then by the united lashing movement of their flagella the cluster of eight swarm-cells swims away (fig. 4). They may remain connected for an hour or more, but eventually become detached, and resemble the swarm-cells of the *Endosporeae* as above described. The swarm-cells have been observed to pass into the amoeboid stage, as in the *Endosporeae*, but the fusion of these amoebae to form a plasmodium has not been directly observed.

*The Plasmodium.*—Several of the phenomena which are met with in the swarm-cell may be seen in the plasmodium on an extended scale. Like the former when in the amoeboid phase, it is endowed with power of locomotion, and advances over the substratum with a creeping movement. The interior substance consists of granular protoplasm, containing numerous nuclei and vacuoles. The latter vary in size, and are often seen to contract and discharge their contents, which are either watery or contain refuse matter. The movements in the interior of the swarm-cell are extended into a systematic circulation in the plasmodium, which spreads in a network of veins with a few principal channels. Through these the granular substance streams in a rapid torrent which gradually comes to a pause in the space of a minute and a half to two minutes, and then immediately reverses its course. A rhythmic flow is thus maintained backwards and forwards at nearly equal intervals, but always of somewhat longer duration in the direction in which the plasmodium is creeping. The flow is continued from the larger to the smaller veins which branch with increasing intricacy till they are lost in the broad tumid margin of the advancing plasmodium (see *Frontispiece*). The whole is invested by a layer of hyaloplasm devoid of granular particles, but merging imperceptibly into the inner stratum. The hyaloplasm exhibits amoeboid movements, projecting and withdrawing pseudopodia, and is unequal in thickness over

different parts; it is generally abundant at the advancing margin. The hyaloplasm appears to be a more firm condition of the protoplasm assumed when exposed on the surface. How far it may have a relation to the rhythmic streaming of the plasmodium, or what causes that movement, has not been ascertained. The track where a plasmodium has passed is marked by a large residuum of substance free from granules and charged with refuse matter.

The description given above applies to plasmodia which creep over dead leaves or the surface of logs or woody fungi. Those which inhabit the interior of rotten wood usually emerge only at the time of spore-formation, and then appear as cushion-like masses or as scattered globules. The plasmodia of the *Calcarineae* contain granules of calcium carbonate (designated "lime"). The granules vary in abundance in different species, being small and inconspicuous under the microscope in some, while in the opaque white plasmodium of *Diderma hemisphericum* they appear like crowded glass beads  $2\ \mu$  or more in diameter, and greatly impede the streaming movement. The colour of the plasmodium is usually either white, yellow, or pink; in some cases it is purple or green. It is generally constant in each species. An exception occurs in *Trichia decipiens*, which usually rises from rotten wood in rosy pink globules, but frequently the plasmodium is watery white; the two colours are not met with together in the same growth, but the sporangia from each are identical in all characters. *Dianema depressum* has, as a rule, a white plasmodium, but occasionally pink.

De Bary's statement that "union never takes place between plasmodia of different species"\* is fully borne out by the experience of others, and no satisfactory evidence to the contrary has been obtained.

The food of plasmodia varies according to the species. Those which live among dead leaves spread with veins which are brown from the incorporation of decayed vegetable matter, and the refuse is discharged shortly before they form into sporangia. The plasmodium of *Badhamia panicea* thrives on the inner bark of felled elms, and is difficult to discern on the red-brown substratum owing to the fragments of bark with which it is densely charged; it becomes pure white by the rejection of enclosed matter before fruiting. Occasionally the question of food is somewhat obscure; for example, the plasmodium of *Amaurochaete fuliginosa* rises in cushions from half an inch to two inches in diameter from the hard and apparently sound wood of Scotch firs; that of *Stemonitis splendens* may also be found emerging from the sawn

\* De Bary, l.c., 426.

surface of fir stumps which show no sign of decay, and covering an area of six to seven square inches. Whatever solid matter these plasmodia may have ingested has been parted with before leaving the wood, but it appears probable that their food was absorbed in a state of solution. The plasmodium of *Badhamia utricularis* is one of the very few we are acquainted with that feed on living fungi. It is capable of being cultivated without limit on *Stereum hirsutum* and allied species, and can be observed under the microscope to dissolve fungus hyphae as the hyaline border of a wave of the yellow plasmodium advances over them.\* The growth of this species is often very rapid; a plasmodium measuring about a square inch in area on a large pileus of *Auricularia mesenterica* has

been seen to increase during twenty hours so as to cover more than six square inches; the vigorous flow extended over the meshes between the veins and produced an unbroken surface.†

The mode in which the multiplication of nuclei takes place requires further investigation. That they sometimes divide by karyokinesis is proved by the case described in *Journ. Linn. Soc. (Bot.)*, xxix. 541. In that instance a plasmodium of *B. utricularis* growing on *Auricularia mesenterica* partly spread in a network of veins over two large cover slips. These

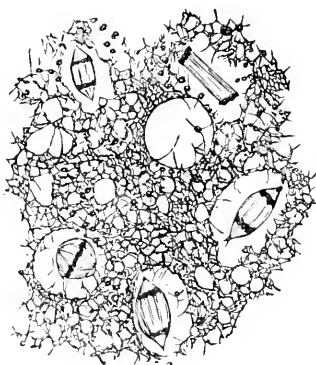


FIG. 5.—*BADHAMIA UTRICULARIS* Berk.

Division of nuclei by karyokinesis in the streaming plasmodium.

From a preparation stained in safranin, and mounted in Canada balsam.

Magnified 1200 times.

films were stained and mounted. In these two preparations the nuclei are seen to be dividing by karyokinesis; the stages represented show the nuclear spindle, and the nuclear plate divided and the two halves still connected by achromatic fibres (fig. 5). Part of the same plasmodium spread over another coverslip, and was killed and stained with the others. The nuclei in this preparation have the appearance most commonly met with, containing a central nucleolus, and without any indication of karyokinetic division. The main body

\* Lister, "Notes on Plasmodium of *Badhamia* and *Brefeldia*," *Ann. Bot.*, ii. 13 (1888).

† Constantineanu has made a number of interesting experiments on the cultivation of *Mycetozoa* with artificially prepared nutritive media; see his paper "Ueber die Entwicklungsbedingungen der Myxomyceten," *Ann. Myc.*, iv. 495 (1906).

of the plasmodium continued to creep over the *Auricularia* for several days after these observations had been made.

This experiment affords clear evidence that under certain conditions the nuclei of the actively streaming plasmodium divide by karyokinesis, but what these conditions are remains at present unexplained. The process no doubt is a rapid one, occupying about half an hour; but the following observations point to the conclusion arrived at from many previous experiments, that it is not the only way by which the nuclei increase in number. A rapidly increasing plasmodium of *Badhamia* spread over two pilei of *Auricularia* in the course of fourteen hours; during this period a portion of the plasmodium was taken every quarter of an hour, and smeared on a coverslip and stained. Each of the fifty-five mountings shows the nuclei in the usual vast abundance, suggesting that their numbers had increased, *pari passu*, with the growth of the plasmodium, and in none of them is there any appearance of karyokinetic division. From the time occupied by the karyokinetic process in the maturing sporangium we are satisfied that it could not have escaped detection if it had occurred during those fourteen hours (fig. 6). It would therefore appear probable that a multiplication of nuclei had taken place by some other means. They vary in size from  $2.5$  to  $5\mu$ . Occasionally there are appearances which strongly suggest that simple division of a nucleus is taking place. Some days later

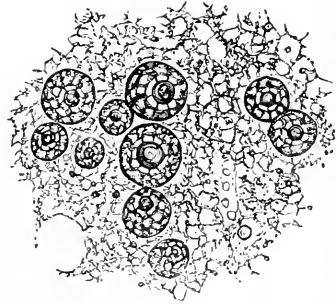


FIG. 6.—*BADHAMIA UTRICULARIS* Berk.

Group of nuclei from actively feeding plasmodium that covered two pilei of *Auricularia* in fourteen hours, showing the irregular size of the nuclei and large nucleoli. Stained in picro-carmin and mounted in Canada Balsam. Magnified 1200 times.

when the plasmodium had ceased to feed, and was collecting together to form into sporangia, stainings showed the nuclei more equal in size, measuring  $4$  to  $5\mu$  in diameter. This experiment may be taken to add materially to the evidence that under some conditions the increase in the number of the nuclei is brought about by simple division.\*

The plasmodium of the exosporous *Ceratiomyxa* issues from the interior of rotten wood to form cushion-like heaps which rapidly extend into columnar or branching sporophores. As

\* I learn by correspondence with Dr. Jahn that in preparations of creeping plasmodium made at successive intervals he has again obtained the mitotic division of the nuclei. Dr. Jahn inclines to the view that the increase of nuclei in the plasmodium occurs solely by this process, but as stated in the text, it is desirable that further investigation as to the mode of increase should be made.—G. L.

the streaming movement common to both divisions of the Mycetozoa is not described by Famintzin and Woronin in their valuable paper on *Ceratiomyxa*,\* the following observations may be given. Rounded cushions of plasmodium were placed under a cover-slip supported at the margins by wet blotting-paper, and were thus enclosed in a moist chamber. The plasmodium spread in a film over the glass, and eventually developed into healthy sporophores. At the earliest stage that could be observed under the microscope the plasmodium was seen to be sharply differentiated into two elements—a hyaline part which ultimately forms the principal constituent of the gelatinous column of the young sporophore, and the granular protoplasm containing numerous small nuclei. In the film on the cover-glass the granular substance spread in a network of veins through the hyaline portion. Through these veins the protoplasm streamed in rhythmic flow, first in one direction and then in the other, at the same intervals of time as in the *Endosporeae*.

*The Sclerotium.*—Plasmodia may pass into the resting stage or sclerotium, and this change may be induced by exposure to dry air. In some cases, however, it occurs when water and apparently food material are present, and the cause for the change is then difficult to discover. As the plasmodium of *Badhamia utricularis* becomes dry, the streaming movement gradually ceases, and the granular protoplasm becomes aggregated in discrete masses surrounded by hyaloplasm; the refuse matter is thrown out, and a membranous cyst-wall forms round each mass, which also includes 10 to 20 nuclei; the cysts become packed into thick agglomerations of irregular shape, drying to a horny consistence.† The changes of outline seen in the maturing sclerotia cannot be merely the effect of shrinking from drying, and as under the microscope we frequently observe the cysts along the margin of a forming sclerotium creep among each other with amoeboid movement, it is probable that the change in shape of the mass may thus be accounted for. The sclerotium of this species can revive after preservation in a dry state for three years, on being placed in water. Recently formed sclerotium resumes the streaming condition in a few hours, but after remaining dry for more than a year it requires to be kept wet for some days before the movement begins; the cyst-walls are then absorbed, and their contents coalesce. It frequently happens that parts of old sclerotia are incapable of resuscitation, but they afford a pabulum for the newly awakened plasmodium, through whose veins the cysts may be seen to be carried along and broken up. The sclerotium of *Didymium squamulosum*

\* "Ueber *Ceratiomyxa hydnoides*," Mém. Acad. Pétersbourg, xx. 3 (1873).

† Lister, "Notes on Plasmodium of *Badhamia* and *Brefeldia*," Ann. Bot., ii. 13 (1888).



is sprinkled over with a deposit of crystals of lime, and after being revived the cyst-walls are not dissolved as in *Badhamia*, but remain as empty hyaline sacs when the contents have crept out. The formation of sclerotium in plasmodia inhabiting the interior of rotten wood is less easy to follow, but it is probably of frequent occurrence. A plasmodium of *Stemonitis fusca*, cultivated from spores in a moist chamber, passed into the resting state a few days after it had formed, spreading in a single layer of crowded cysts on the surface of the glass. This sclerotium was dried and re-wetted, when it revived, and the cyst-walls were dissolved; the cultivation was conducted with pure water, with no attempt to supply nourishment, and the plasmodium returned to the encysted condition in about twenty-four hours; it was again dried and again revived, but afterwards it reassumed the sclerotium state, from which it could not be reawakened.

*The Sporangium and Sporophore.*—The formation of the sporangium in the *Endosporeae* has been minutely described by de Bary,\* and a brief notice of the general characters will be sufficient here. The plasmodium usually leaves the moist surroundings where it has been feeding and creeps to some drier place more suited to the dispersion of the spores. It concentrates at certain points and develops into sporangia of the forms characteristic of the species. They are either simple, though often densely clustered, or they are combined into an *aethalium*, a cushion-like structure consisting of numerous convoluted or imperfectly-defined sporangia. The simple forms are either symmetrical, with or without a stalk, or they are unsymmetrical, spreading on the substratum with an irregular outline, when they are called *plasmodiocarps*. In most cases the shape of the sporangium is nearly constant, though in others it is subject to much variation. Two abundant species, *Physarum nutans* and *Didymium squamulosum*, may be mentioned as examples of variable habit; in each of them we often find vein-like plasmodiocarps, and symmetrical sporangia both stalked and sessile resulting from the same plasmodium. It is true of the shape of the sporangium, as it is of the size of the spores and the form and colour of the capillitium, that though a valuable guide, it cannot be taken as supplying a rigid specific character. The want of a sufficient series of specimens showing how widely a species may vary, has led to the multiplication of names without adequate grounds.

In examining the rising sporangia of *Physarum nutans* in a moist chamber under the microscope, the projecting masses of plasmodium are seen to pulsate, swelling or shrinking as the

\* l.c., 424.

rhythmic flow advances or retreats, but gradually growing with the advancing movement. As the sporangia develop, an envelope, the *sporangium-wall*, is secreted by the protoplasm at the surface. This is at first of a gelatinous consistency, but ultimately becomes membranous. Simultaneously a system of branching anastomosing threads, the *capillitium*, is secreted in the interior of the sporangium, forming a network traversing the still homogeneous protoplasm. The basal part of each young sporangium contracts and forms a stalk consisting of a tube of tougher hyaline substance, the continuation of the sporangium-wall, through which the

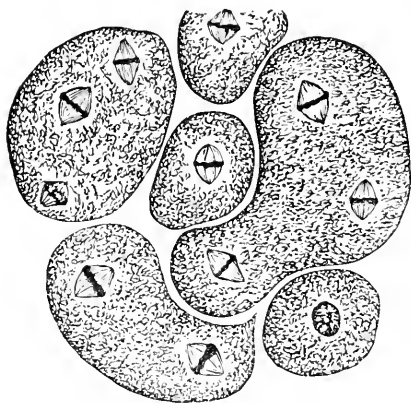


FIG. 7.—*COMATRICHA NIGRA* Schroeter.

From a stained preparation of a young sporangium, showing the spore-plasm separated into rounded masses about groups of nuclei, which are dividing by karyokinesis; the nuclear division has reached the "spindle stage"; the spindles are seen in profile in all cases but one in which the equatorial plate is seen from one of the poles of the spindle. Magnified 1200 times.

protoplasm continues to flow until the surrounding veins have emptied their contents into the spherical head. The coarse refuse matter which has not been discharged along the track of the plasmodium, where it often takes the form of a *hypothallus* connecting the sporangia, is deposited in the centre of the stalk.

In the genus *Physarum* the lime-granules which abounded in the plasmodium are in part incorporated in the wall-substance, and in part deposited within *lime-knots* or vesicular

swellings of the hyaline threads of the capillitium. In *Didymium* the lime-granules which can be seen in the plasmodium are dissolved in the sporangium, and the salt in solution passing through the soft sporangium-wall forms into crystals on the outer surface. The various kinds of capillitium represented in the different genera and species are described in the text. In all genera that possess a capillitium, this structure is developed before spore-formation.

The formation of spores in the *Endosporae* is preceded by the division of the nuclei in the spore-plasm by karyokinesis. The process was first recorded by Strasburger as occurring in the genus *Trichia*.\* Recent observations show that this

\* Botan. Zeit., xlii. 305 (1884).

mode of nuclear division takes place in the sporangium only once, and occurs almost simultaneously in all the nuclei rather more than an hour before the spores begin to be formed. It is difficult to ascertain the exact number of the chromosomes on account of their small size; Harper\* counted twelve in *Fuligo*, and Jahn† considers the number in *Trichia* and *Arcyria* to be sixteen ("eight double chromosomes").

In *Badhamia*, *Physarum*, *Craterium*, *Didymium*, *Stemonitis*, *Lamproderma*, and *Comatricha*, when the spindle stage is reached, the plasma breaks up into lobed masses containing six to ten nuclei (fig. 7). During the later stages of nuclear division these become sub-divided until reduced to masses of two spores' capacity, each containing a pair of nuclei resulting from a division (fig. 8). By a final constriction these divide into the ultimate spores, each containing a single nucleus. In a short time the spore-wall is acquired, and the active stage of the organism comes to a close.

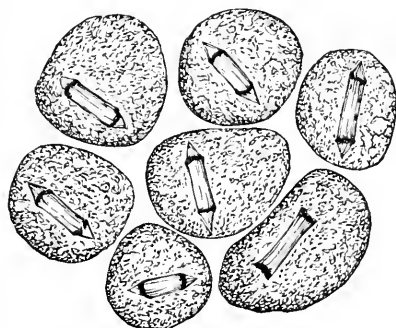


FIG. 8.—*COMATRICHIA NIGRA* Schroeter.

From a stained preparation of a young sporangium, showing the plasma separated into masses of two spores' capacity round the nuclei, which have almost divided by karyokinesis. Magnified 1200 times.

In the genera just mentioned, spore-formation occurs in warm weather about twenty hours after the sporangia have taken form. In

*Trichia* the interval is much longer, extending from two to four days according to the temperature. In this genus and also in *Arcyria*, *Lycogala*, and *Reticularia* the spore-plasm is not seen to separate in lobed masses at the time when the nuclear spindle is formed, but the karyokinetic process is completed and the daughter-nuclei are definitely parted from one another before the plasma breaks up and encloses each nucleus in a young spore.

The sporophores of *Ceratiomyxa* are columnar, or confluent and interlacing. In their early stage the protoplasmic matter spreads throughout the superficial part of the columns, and also in numerous veins traversing the watery gelatinous interior substance. These veins are ultimately withdrawn to the outer layer, where they form a close network. The

\* Botanical Gazette, xxx, 217 (1900). † Myxomycetenstudien—6. Kernverschmelzungen und Reduktionsteilungen, Ber. Deutsch. Bot. Gesell., xxv, 24 (1907).

nuclei now divide by karyokinesis;\* the network of protoplasm then spreads out to form a continuous superficial covering, which rapidly divides into polyhedral portions or cells of equal size, each containing a single nucleus. The whole sporophore is invested by a thin hyaline layer. The contents of each cell now rise as a shortly cylindrical projection from the surface of the sporophore, carrying with it a hyaline investment, which becomes constricted at the base until an elongated membranous stalk is formed, bearing at its apex a globule, the young spore, consisting of granular protoplasm and a nucleus. This nucleus now divides twice by karyokinesis.† The mature spore, an ellipsoid body enclosed in a membranous wall, thus contains four nuclei. It is easily detached from the stalk, and the gelatinous sporophore dries to a membrane of the frailest structure, to disappear with the first shower of rain. It is probable that the sporophores of *Ceratiomyxa* may be regarded as representing the sporangia of the *Endosporeae*. We have in both cases supporting structures and spore-plasm, the nuclei of which divide by karyokinesis shortly before the spores are formed. The mature spore in *Ceratiomyxa* is more advanced than that of the *Endosporeae* in that the nucleus has already undergone two divisions within the spore.

*Distribution and Specific Characters.*—The geographical distribution of many of the species is very wide, as might be expected from the ease with which their minute spores can be carried by currents of air. Some, however, appear to be characteristic of warmer climates, such as *Physarum roseum*, *Physarella oblonga*, *Trichamphora pezizoidea*; while others are usually found in alpine regions in the neighbourhood of melting snow, e.g. *Diderma niveum*, *Lepidoderma Carestianum*, *Lamproderma violaceum* var. *Carestiae*.‡

In England some species may occur at any season of the year after moist weather, e.g. *Physarum nutans*, *Craterium minutum*, *Didymium squamulosum*, *Trichia varia*; others again appear only in the summer and autumn, e.g. *Physarum psittacinum*, *Stemonitis herbatica*, *Dictydium cancellatum*, and most of those species that inhabit heaps of old straw.

The main characters distinguishing the different species are remarkably constant in sporangia gathered in all parts of the world. Specimens of *Hemitrichia clavata*, *H. Serpula*, *Dictydium cancellatum*, and *Trichia decipiens*, have been

\* See Jahn in Ber. Deutsch. Bot. Gesell., XXVIA 342-352 (1908). † Jahn, op. cit., XXV. 25 (1907); Olive in Trans. Wisc. Ac. Sci., XV. 753 (1907).

‡ M. Meylan has published interesting observations on the species occurring at different elevations and seasons in the Jura Mountains (see Bull. Soc. Vaud., XLIV. 285-302, 1908).

obtained from Europe, India, and North and South America identical to the most minute microscopic detail; and numerous other equally stable forms might be cited. On the other hand, in many instances intermediate forms occur whose position is difficult to assign. In some cases it is possible to regard climatic or seasonal conditions as the cause of variation. The American and tropical examples of the genus *Cribraria* are more elegant in form than individuals of the same species found in Britain and on the Continent, and most of them show a tendency towards the great regularity typical of *C. intricata*, a striking and well-marked species which is abundant in those regions, but rare in our less brilliant atmosphere. The more elegant growth in the American species is not confined to the genus *Cribraria*, but is of general occurrence; and it is probable that this modification of type is due to the influence of climate. This is what might be looked for when we consider the effects which changes of weather produce in the development of sporangia in this country. On old decaying stumps which can be kept under observation for several years, growths of *Trichia affinis* may year after year present the same typical characters, only differing in the elaters in one season being slightly thicker than those in another. But should cold weather set in while the plasmodium is rising, the arrangement of the spiral bands may be so abnormal as to suggest a marked variety. With a return of milder weather, however, the original form reappears, leaving no doubt that all have been derived from a common parentage. In some extensive gatherings of the same species which have matured in hot, dry weather, the elaters are so reduced in size as scarcely to exceed the diameter of a spore in length, though the sporangia are perfectly normal in form and the spores are marked with the typical sculpture. Developments of *Trichia persimilis* of the typical form have been followed after a few nights' frost by a growth in which the short and nearly smooth elaters closely resemble those of *Oligonema nitens*, though the spores and the shape of the sporangia retain the normal character. In *Stemonitis*, *Lamproderma*, *Prototrichia*, and other genera, great modifications are caused by changes of temperature. But, after all allowance has been made for such agencies, it must be recognized that certain species are subject to variation for which no cause can be given.

In the systematic account of the *Mycetozoa* the descriptions given are those of the most frequent type of each species. Subordinate types representing distinct centres about which examples group themselves, but connected with the main type by gradations of character, are described as varieties.

*Systematic Arrangement.*—In preparing this Catalogue of the collection of *Mycetozoa* in the British Museum, the arrangement of orders and genera given by Rostafinski in his Monograph\* has in the main been followed, with such alterations as observations made during recent years have rendered necessary. De Bary made the group the subject of minute and thorough investigation; † and Rostafinski, while studying under him at Strassburg, devised a system of classification which is clear and comprehensive, and is now generally accepted.

The division by Rostafinski of the main section *Endosporeae* into two parts, distinguished by the colour of the spores, has been objected to as being artificial and wanting in universal application, but the cases which offer difficulty with regard to their position under this scheme are few, and on the whole the species range themselves under the separate heads in a remarkably natural manner.

Although the search for specimens of the *Mycetozoa* has been comparatively limited, owing, no doubt, to the small size of the objects, yet in consequence of the persistent nature of the sporangia, we possess, in the different herbaria, specimens representing the gatherings from many countries during more than half a century, and some of them dating back a hundred years. Where they have escaped rough treatment, they completely retain their specific characters. When we consider the cosmopolitan distribution of the species, owing, we may conclude, to the long-continued vitality and minuteness of the spores, it may be doubted whether any hitherto unsearched region will add very largely to the number with which we are already acquainted. It is their life history which is at present imperfectly known, and it is in this direction that the important work of the future must lie.

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\* Sluzowce (*Mycetozoa*) Monographia (Paris : 1875).

† Comp. Morph. and Biol. Fungi, *Mycetozoa*, etc., 421.

## SYNOPSIS OF ORDERS AND LIST OF GENERA OF MYCETOZOA

### Subclass I.—EXOSPOREAE.

Spores developed outside a sporophore. (P. 25.)

Order I.—CERATIOMYXACEAE. Sporophores membranous, branched; spores white, borne singly on filiform stalks arising from the areolated sporophore. (P. 25.)

Genus 1. *Ceratiomyxa* Schroeter. (P. 25.)

### Subclass II.—ENDOSPOREAE.

Spores developed inside a sporangium.

Cohort I.—AMAUROSPORALES. Spores violet-brown\* or purplish-grey (ferruginous in *Stemonitis ferruginea* and *S. flavogenita*, colourless in *Echinostelium*). (P. 26.)

Subcohort I.—CALCARINEAE. Sporangia provided with lime (calcium carbonate). (P. 26.)

Order I.—PHYSARACEAE. Lime in the form of minute round granules (occasionally in rounded nodules in *Diacaea*). (P. 26.)

- Genus 2. *Badhamia* Berk. (P. 30.)  
3. *Physarum* Pers. (P. 40.)  
4. *Fuligo* Haller. (P. 85.)  
5. *Erionema* Penzig. (P. 89.)  
6. *Trichamphora* Jungh. (P. 89.)  
7. *Physarella* Peck. (P. 91.)  
8. *Cienkowskia* Rost. (P. 92.)  
9. *Craterium* Trentep. (P. 93.)  
10. *Leocarpus* Link. (P. 98.)  
11. *Diderma* Pers. (P. 99.)  
12. *Colloderma* G. Lister. (P. 116.)  
13. *Physarina* von Höhnelt. (P. 117.)  
14. *Diachaea* Fries. (P. 117.)

Order II.—DIDYMIACEAE. Lime in crystals deposited outside the sporangium-wall. (P. 122.)

- Genus 15. *Didymium* Schrad. (P. 123.)  
16. *Mucilago* Adanson. (P. 137.)  
17. *Lepidoderma* de Bary. (P. 139.)

\* The colours of the spores are given throughout as they are seen when magnified and with transmitted light.

Subcohort II. — *AMAUROCHAETINEAE*. Sporangia without lime. (P. 141.)

Order I.—*STEMONITACEAE*. Sporangia distinct, provided with a stalk and columella. (P. 141.)

- Genus 18. *Stemonitis* Gled. (P. 143.)
- 19. *Comatricha* Preuss. (P. 151.)
- 20. *Enerthenema* Bowm. (P. 160.)
- 21. *Lamproderma* Rost. (P. 161.)
- 22. *Clastoderma* Blytt. (P. 169.)
- 23. *Echinostelium* de Bary. (P. 170.)

Order II.—*AMAUROCHAETACEAE*. Sporangia combined to form an aethalium. (P. 170.)

- Genus 24. *Amaurochaete* Rost. (P. 171.)
- 25. *Brefeldia* Rost. (P. 172.)

Cohort II.—*LAMPROSPORALES*. Spores variously coloured, not violet-brown or purplish-grey (except in *Licea minima* and *Listerella*, q.v.).

Subcohort I.—*ANEMINEAE*. Capillitium wanting, or if present not forming a system of uniform threads (except in *Alvisia*, q.v.). (P. 173.)

Order I.—*HETERODERMACEAE*. Sporangium-wall membranous, beset with microscopic round plasmodic granules, and (except in *Lindbladia*) forming a net in the upper part. (P. 173.)

- Genus 26. *Lindbladia* Fries. (P. 174.)
- 27. *Cribraria* Pers. (P. 175.)
- 28. *Dictydium* Schrad. (P. 185.)

Order II.—*LICEACEAE*. Sporangia solitary; sporangium-wall cartilaginous (membranous in *Licea biforis*). (P. 186.)

- Genus 29. *Licea* Schrad. (P. 187.)
- 30. *Orcadella* Wing. (P. 190.)

Order III.—*TUBULINACEAE*. Sporangium-wall membranous, without plasmodic granules; sporangia clustered, cylindrical or ellipsoid. (P. 190.)

- Genus 31. *Tubifera* Gmelin. (P. 191.)
- 32. *Alvisia* Berk. & Br. (P. 193.)

Order IV.—*RETICULARIACEAE*. Sporangia closely compacted and usually forming an aethalium; sporangium-walls usually incomplete or forming a spurious capillitium; true capillitium none, or in *Liceopsis* consisting of a few branching threads or strands. (P. 194.)



- Genus 33. *Dictydiaethalium* Rost. (P. 196.)  
34. *Enteridium* Ehrenb. (P. 197.)  
35. *Reticularia* Bull. (P. 198.)  
36. *Liceopsis* Torrend. (P. 199.)

Order V.—LYCOGALACEAE. Sporangia forming an aethalium; pseudo-capillitium consisting of branched colourless tubes. (P. 200.)

- Genus 37. *Lycogala* Adanson. (P. 200.)

Subcohort II.—CALONEMINEAE. Capillitium present as a system of uniform or sculptured threads. (P. 204.)

Order I.—TRICHIACEAE. Capillitium consisting of tubular threads, which are either free and unbranched ("elaters"), or form a network branching at wide angles; thickenings in the form of spirals or rings. (P. 204.)

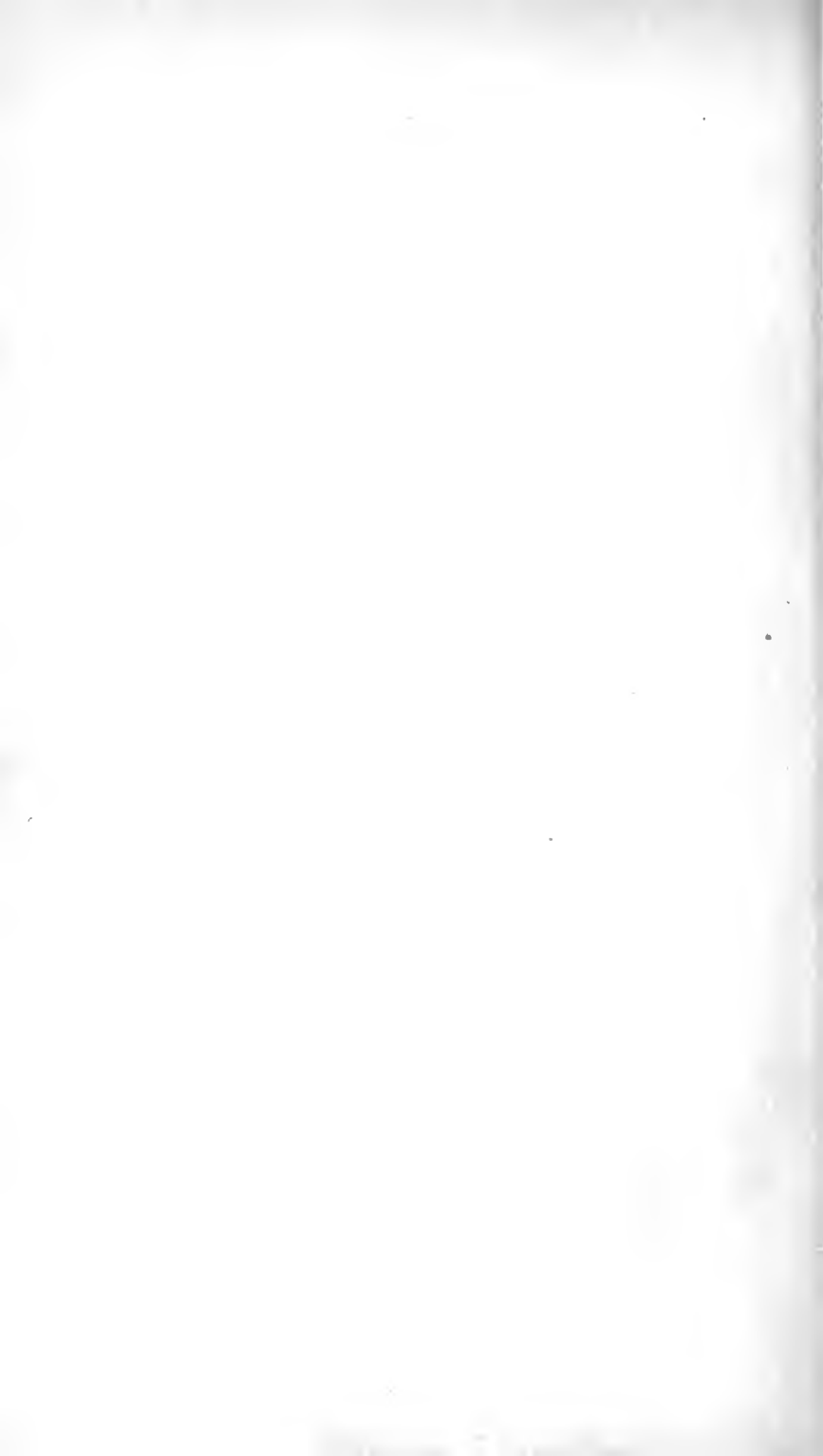
- Genus 38. *Trichia* Haller. (P. 205.)  
39. *Oligonema* Rost. (P. 219.)  
40. *Calonema* Morgan. (P. 221.)  
41. *Hemitrichia* Rost. (P. 222.)  
42. *Cornuvia* Rost. (P. 231.)

Order II.—ARCYRIACEAE. Capillitium a network of tubular threads branching at wide angles and thickened with cogs, half rings (rings in *Arcyria annulifera*), spines, or warts (capillitium often scanty and of free threads in *Perichaena corticalis*). (P. 231.)

- Genus 43. *Arcyria* Wiggers. (P. 232.)  
44. *Lachnobolus* Fries. (P. 246.)  
45. *Perichaena* Fries. (P. 247.)

Order III.—MARGARITACEAE. Capillitium consisting of solid threads, either coiled and hair-like or nearly straight and attached to the sporangium-wall, simple or branching at acute angles. (P. 254.)

- Genus 46. *Margarita* Lister. (P. 256.)  
47. *Dianema* Rex. (P. 257.)  
48. *Prototrichia* Rost. (P. 260.)  
49. *Listerella* Jahn. (P. 261.)
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## MYCETOZOA.

### Subclass I.—EXOSPOREAE.

Spores developed outside the sporophores.

#### ORDER I.—CERATIOMYXACEAE.

Sporophores membranous, branched; spores white, borne singly on filiform stalks rising from the areolated sporophore.

Genus 1.—**CERATIOMYXA** Schroeter in Engler & Prantl Nat. Pflanzenfam., I. i. 16 (1889). Sporophores consisting of membranous processes, either branching from a common base or forking repeatedly or forming a network; the surface is mapped out into polyhedral areolae, from the centre of each of which arises a slender stalk bearing a single ellipsoid colourless spore.—*Ceratium* Alb. & Schw. Consp. Fung., 358 (1805) *non* Schrank (1793).

Fig. 9.—*Ceratiomyxa fruticulosa* Macbr.

- a. Clusters of sporophores. Twice natural size.
- b. Sporophore. Magnified 40 times.
- c. Four areolae of mature sporophore; one spore still attached to its stalk, and another free. Magnified 480 times.

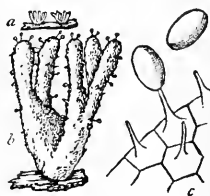


Fig. 9.

1. **C. fruticulosa** Macbr. N. Am. Slime-Moulds, 18 (1899). Plasmodium usually colourless. Sporophores white or pinkish-yellow, membranous, forming a tuft of simple or forked fasciculate branches 1 mm. or more high, .07 mm. thick, or consisting of more or less anastomosing broad bands, from which arise irregular lobes. Spores white, smooth, ovoid,  $10 \times 6$  to  $13 \times 7 \mu$ .—*Byssus fruticulosus* Muell. in Fl. Dan., fasc. xii. 6, t. 718, fig. 2 (1777). *Tremella hydnoidea* Jacq. Misc., i. 145, t. 16 (1778). *Clavaria puccinea* Batsch Elench. Fung., 139, fig. 49 (1783). *C. byssoides* Bull. Champ., 209, t. 415, fig. 2 (1791). *Puccinia byssoides* Gmel. Syst. Nat., 1462 (1791). *Isaria mucida* Pers. in Roemer N. Mag. Bot., i. 121 (1794). *Ceratium hydnoides* Alb. & Schw. Consp. Fung., 358 (1805); Fr. Syst. Myc. iii. 294.

Fam. & Wor. in Mém. Acad. Imp. Petersb., sér. 7, xx. 4 (1873); Zopf Pilzthiere, 69 & 174; de Bary Comp. Morph. Fungi, 432; Cooke Brit. Fungi, ii. 550. *C. pyxidatum* Alb. & Schw. Consp. Fung., 359. *Ceratiomyxa mucida* Schroet. in Engl. & Prantl Nat. Pflanz., I. i. 16 (1889); Lister Mycetozoa, 25 (1894).

Var. 1.—**flexuosa** Lister: sporophores elongated, slender, white, profusely branching but not anastomosing, 2 to 5 mm. high.—*Ceratiium arbuscula* Berk. & Br. in Journ. Linn. Soc., xiv. 97 (1873). *C. filiforme* Berk. & Br. l.c.

Var. 2.—**porioides** Lister: sporophores densely compacted to form a honeycomb-like growth, superficially resembling *Polyporus vulgaris* Fr., though more minute. *Ceratiium porioides* Alb. & Schw. l.c. *Ceratiomyxa porioides* Schroet. l.c.; Macbr. l.c., 19.

Pl. 1.—*a*. Sporophores of typical form (England); *b*. sporophores of var. *flexuosa* (Ceylon); *c*. sporophores of var. *porioides* (Iowa); *d*. clavate end of sporophore; all the spores but five have fallen from their stalks; *e*. spore.

Intermediate forms connecting the two varieties with the type are of frequent occurrence. The plasmodium is sometimes yellowish-pink in colour.

*Hab.* On rotten wood; common and widely distributed.—Lyme Regis (B.M. 1166); Borneo (B.M. 1167); Iowa (B.M. 1169): var. *flexuosa*—Ceylon (B.M. 1578); Brisbane (B.M. 1579); Japan (B.M. 2301): var. *porioides*—Upsala (B.M. 1168); Iowa (B.M. 1025).

## Subclass II.—ENDOSPOREAE.

Spores developed within sporangia.

### Cohort I.—AMAUROSPORALES.

Capillitium present. Spores violet-brown or purplish-grey (ferruginous in *Stemonitis ferruginea* and *S. flavogenita*, colourless in *Echinostelium*).

#### Subcohort I.—CALCARINEAE.

Deposits of lime either (*a*) in minute granules included in the sporangium-wall, in expansions of the capillitium or in the stalk; or (*b*) in the form of stellate or lenticular crystals scattered over the sporangium-wall.

### ORDER I.—PHYSARACEAE.

Deposits of lime in minute round granules more or less aggregated, included in the sporangium-wall and in vesicular expansions of the capillitium (=lime-knots), except in *Diderma*, *Colloderma* and *Physarina* where there are no lime-knots, and in *Diachaea*, in which the lime is confined to the stalk and columella and is sometimes in the form of rounded nodules.

KEY TO THE GENERA OF *PHYSARACEAE*.

A. Capillitium a coarse network charged with lime throughout.  
(2) *BADHAMIA*.

Fig. 10.—*Badhamia utricularis* Berk.

- a. Cluster of sporangia. Magnified  $3\frac{1}{2}$  times.  
b. Fragment of capillitium and spore-cluster. Magnified 140 times.

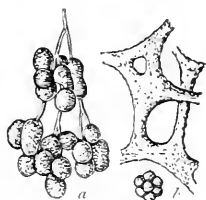


Fig. 10.

B. Capillitium a network of slender threads with vesicular expansions filled with lime-granules (lime-knots).

a. Sporangia combined into a convolute aethalium.

(4) *FULIGO*.

Fig. 11.—*Fuligo septica* Gmel.

- a. Aethalium. One-third natural size.  
b. Capillitium threads with lime-knots and two spores. Magnified 120 times.

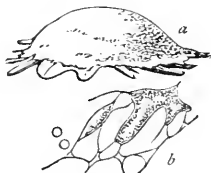


Fig. 11.

b. Sporangia single, scattered or aggregated.

Sporangia subglobose, lenticular, or in the form of plasmodiocarps; capillitium without free hooked branches.

(3) *PHYSARUM*.

Fig. 12.—*Physarum nutans* Pers.

- a. Two sporangia. Magnified 9 times.  
b. Capillitium threads, with lime-knots, attached to a fragment of the sporangium-wall. Magnified 110 times.

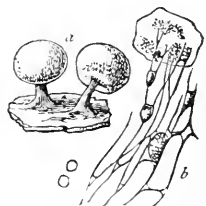


Fig. 12.

Sporangia long, cylindrical, branching; capillitium a close elastic network, with minute lime-knots.

(5) *ERIONEMA*.

Fig. 13.—*Erionema aureum* Penzig.

- a. Cluster of sporangia. Magnified 6 times.  
b. Capillitium and spores. Magnified 140 times.

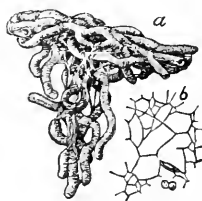


Fig. 13

Sporangia saucer-shaped on dark reddish stalks.

(6) TRICHAMPHORA



Fig. 14.

Fig. 14.—*Trichamphora pezizoidea* Jungh.

a. Group of sporangia. Magnified  $5\frac{1}{2}$  times.

b. Capillitium with two spores. Magnified 140 times.

Sporangia shortly cylindrical, tubular, stalked.

(7) PHYSARELLA.



Fig. 15.

Fig. 15.—*Physarella oblonga* Morg.

Two sporangia, one perfect, the other dehiscent in revolute lobes from the funnel-shaped columella. Magnified  $6\frac{1}{2}$  times.

Plasmodiocarps cylindrical, branching and anastomosing; capillitium with free hooked branches; lime-knots taking the form of vertical plates.

(8) CIENKOWSKIA.

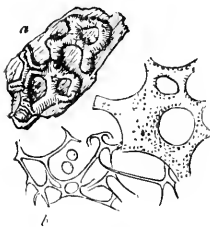


Fig. 16.

Fig. 16.—*Cienkowskia reticulata* Rost.

a. Part of branching plasmodiocarp. Magnified 4 times.

b. Capillitium threads and part of a perforated lime-plate. Magnified 140 times.

Sporangia in the shape of a covered goblet, ovoid; stalks cartilaginous.

(9) CRATERIUM.

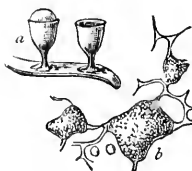


Fig. 17

Fig. 17.—*Craterium minutum* Fr.

a. Two sporangia; in one the lid has fallen away. Magnified 10 times.

b. Capillitium with lime-knots and two spores. Magnified 110 times.

Sporangia ovoid, shining, clustered; stalks membranous.

(10) LEOCARPUS.

Fig. 18.—*Leocarpus fragilis* Rost.

- a. Cluster of sporangia. Magnified  $2\frac{1}{2}$  times.  
b. Hyaline threads and a branching lime-knot of the capillitium, with two spores. Magnified 120 times.

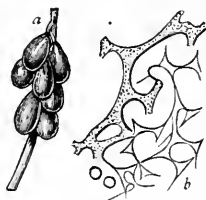


Fig. 18.

C. Capillitium without lime-knots.  
Sporangium-wall opaque, smooth.

(11) DIDERMA.

Fig. 19.—*Diderma testaceum* Pers.

- a. Group of three sporangia; in the upper one the double wall is broken away in part and the columella exposed. Magnified 9 times.  
b. Portion of the outer and inner layers of the sporangium-wall, to the latter the capillitium threads are attached; three spores. Magnified 170 times.

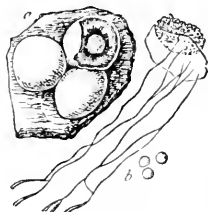


Fig. 19.

Outer sporangium-wall gelatinous, translucent when moist;  
inner wall membranous.

(12) COLLODERMA.

Fig. 20.—*Colloderma scutatum* G. Lister.

- a. Moistened sporangium; the dark mass of spores shows through the translucent walls. Magnified 13 times.  
b. Capillitium and spores. Magnified 140 times

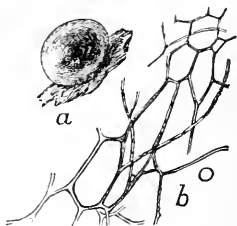


Fig. 20.

Sporangium-wall opaque, rough with numerous blunt peg-like prominences.

(13) PHYSARINA.

Fig. 21.—*Physarina echinocephala* von Höhnelt.

- a. Sporangia. Magnified 15 times.  
b. Capillitium and spores with fragment of sporangium-wall. Magnified 140 times.



Fig. 21

Sporangium-wall hyaline, without lime.

(14) DIACHAEA.

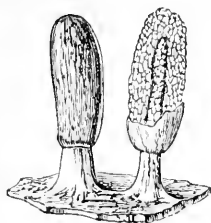


Fig. 22.

Fig. 22.—*Diachaea leucopoda* Rost.

Two sporangia, one entire, the other deprived of the spores and showing capillitium and columella. Magnified 22 times.

Genus 2.—**BADHAMIA** Berkeley in Trans. Linn. Soc., xxi. 153 (1852). Sporangia stalked, sessile, or forming plasmodiocarps; sporangium-wall single, with included lime-granules; capillitium consisting of a coarse network charged with granules of lime (sometimes constricted here and there into narrow hyaline threads); spores clustered or free, warted, reticulated, or nearly smooth.

#### KEY TO THE SPECIES OF *BADHAMIA*.

##### A. Spores clustered:—

##### a. Spores warted chiefly on one side—

##### a. Sporangia 1 to 1.5 mm. diam.—

##### \* Lime in sporangia and capillitium white—

Plasmodium yellow; sporangia grey, clustered or scattered, sessile or with membranous stalks.

1. *B. capsulifera*

Sporangia grey, with firm stalks.

2. *B. papaveracea*

Plasmodium white; sporangia white, heaped.

3. *B. populina*

##### \*\* Lime in sporangia and capillitium yellow.

7. *B. nitens*

$\beta$ . Sporangia 0.3 to 0.5 mm. diam.; capillitium white or apricot-coloured.

8. *B. versicolor*

##### b. Spores equally warted all over.

4. *B. utricularis*

##### B. Spores not clustered:—

##### a. Sporangia yellow or orange.

9. *B. decipiens*

##### b. Sporangia white or grey—

Sporangia globose, sessile or on short membranous stalks; spores violet-brown; plasmodium orange.

5. *B. foliicola*



Sporangia globose on long membranous stalks; spores nearly smooth, blackish. 6. *B. magna*.

Sporangia subglobose, sessile or with firm yellow or brown stalks; spores closely spinulose, dark purple-brown. 10. *B. macrocarpa*

Sporangia subglobose, slightly depressed, sessile or stalked; stalks black below, grey above; spores violet-brown. 11. *B. affinis*

Sporangia discoid, depressed, on short black stalks; spores violet-brown. 12. *B. orbiculata*

Sporangia subglobose, sessile; spores violet-brown, nearly smooth; plasmodium white. 13. *B. panicea*

c. Sporangia chalk-white, sessile, hemispherical or forming plasmodiocarps; spores smooth, ellipsoid.

14. *B. ovispora*

d. Sporangia flesh-coloured or purple-brown—

Sporangia sessile, without a true columella.

15. *B. lilacina*.

Sporangia stalked, stalk continued into the sporangium as a columella.

16. *B. rubiginosa*.

1. *B. capsulifera* Berk. in Trans. Linn. Soc., xxi. 153 (1852). Plasmodium chrome-yellow. Sporangia globose or pyriform, usually sessile, 1 to 1.5 mm. diam., greyish-white; sporangium-wall hyaline, with lime-granules sparsely distributed. Stalk when present membranous, straw-coloured, usually short. Capillitium a network of flat bands with broad thin expansions at the angles; lime-granules evenly but not densely distributed throughout. Spores dark purple-brown, adhering in clusters of 8 to 20, spinulose, more strongly warted on the outer surface as they lie in the cluster, 11 to 13  $\mu$  diam.—Rost. Mon., p. 141. Macbr. N. Am. Slime-Moulds, 68. *Sphaerocarpus capsulifer* Bull. Champ. 139, t. 470, fig. 2 (1791). *Physarum hyalinum* Pers. in Roemer N. Mag. Bot., i. 88 (1794)? *P. cinereum* Link in Berl. Mag., iii. 27 (1809)? *P. capsuliferum* Chev. Fl. Paris. i. 339 (1826). *P. cancellatum* Wallr. Fl. Crypt. Germ., 351 (1833)? *Trichia capsulifer* DC. Fl. Fr., ii. 254 (1805). *Badhamia hyalina* Berk. l.c.; Rost. Mon., p. 139; Lister Mycetozaa, 30. *B. varia* Mass. Mon., 319 (1892), in part.

Pl. 3.—a. sporangia; b. fragment of capillitium with a cluster of spores and one free spore; c. spore; (England).

This species forms small plasmodia. It is subject to considerable variation in the shape of the sporangia, and the clustering and markings of the spores. In some gatherings the spores are greyer and not so

dark as in the type, loosely adhering, and scarcely rougher on one side, not exceeding 10 to 11  $\mu$  diam. All intermediate forms occur between this and the typical form with its large and rather compact clusters of darker larger spores. *B. hyalina* Berk. is described as differing from *B. capsulifera* in having spherical instead of obovate sporangia, but as we not infrequently meet with both spherical and pyriform sporangia intermixed the shape cannot be accepted as distinctive. *B. capsulifera* takes precedence as being the older specific name. Possibly *B. melanospora* Speg. (in Anal. Soc. Cient. Arg., p. 150, 1880) with sessile sporangia and black spores clustered or free measuring 15  $\mu$ , is a form of *B. capsulifera*, but in the absence of the type this must remain uncertain.

*Hab.* On logs of fir, oak, alder, etc.—Batheaston, Somerset (B.M. 36); Bristol (B.M. 79); Leighton, Beds (B.M. 1170); Luton, Beds (1171); Lyme Regis, Dorset (B.M. 1172); France (Paris Herb.); Austria (B.M. 2062); Germany (B.M. 2063); Portugal (B.M. 2087).

**2. *B. papaveracea* Berk. & Rav. in Grev., ii. 66 (1873).** Plasmodium? Sporangia subglobose, greyish-white, nearly smooth, 0.7 to 1 mm. diam., shortly stalked or sessile, gregarious; sporangium-wall with scanty deposits of lime. Stalk firm, dark brown, rarely straw-coloured, 0.2 to 0.3 mm. high. Capillitium as in *B. capsulifera*. Spores purple-brown, closely compacted in clusters of 6 to 10, more strongly warted on the outer third, 10 to 13  $\mu$  diam.—Rost. Mon., App p. 3; Mass. Mon., 323 (in part); Macbr. N. Am. Slime-Moulds, 69. *B. hyalina* var. *papaveracea* Lister Mycetozoa 30 (1894).

Pl. 3.—*d.* sporangia; *e.* two clusters of spores; (New Jersey).

This species is closely allied to *B. capsulifera* and connected with it by intermediate forms; it is distinguished by the firmer stalks and the smaller more compact spore-clusters.

*Hab.* On bark.—Pennsylvania (B.M. 996b); Massachusetts (B.M. 1173); New Jersey (B.M. 1862); Japan (B.M. 1985).

**3. *B. populina* Lister in Journ. Bot., xlii. 129 (1904).** Plasmodium white or cream-white. Sporangia white, subglobose or ovoid, smooth, 1.5 mm. diam., sessile, heaped, or rarely solitary on short yellowish-brown stalks; sporangium-wall with abundant deposits of lime-granules. Capillitium a coarse network of broad strands charged with lime-granules throughout. Spores 10 to 12  $\mu$  diam., in clusters of 16 to 20 or more, purple-brown, minutely warted, the warting rather stronger on one side; they are usually marked by one or more narrow ridges or bands.—Sturgis in Colorado Coll. Publ., Science Ser., xii. 11 (1907).

Pl. 2.—*a.* sporangia; *b.* fragment of capillitium with two clusters of spores and two free spores; *c.* spores; (England).

This species is allied to *B. capsulifera*, but is distinguished by the heaped white sporangia arising from white plasmodium, and by the spores being usually banded. Amongst numerous gatherings made

by Dr. Sturgis and Mr. E. Bethel in Colorado, some sporangia have the dark banded spores characteristic of the English and French specimens, while others have paler spores with little or no banding; these pale-spored forms approach very closely the paler-spored gatherings of *B. capsulifera*, typical examples of which appear to be seldom met with in North America.

*Hab.* On fallen logs of *Populus* and *Negundo*.—Essex (B.M. 1969); France (B.M. 2064); Colorado (B.M. 2065).

4. *B. utricularis* Berk. in Trans. Linn. Soc., xxi. 153. (1852). Plasmodium chrome-yellow. Sporangia ovoid, subglobose, or confluent and lobed, 0.5 to 1 mm. diam., clustered, cinereous or iridescent-violet, often marked with the white attachments of the capillitium, sessile or on membranous straw-coloured branching stalks; sporangium-wall hyaline with sparsely distributed minute granules of lime. Capillitium as in *B. capsulifera*. Spores bright brown or violet-brown, usually adhering in loose clusters of 7 to 10, spinulose, 9 to 12  $\mu$  diam.—Rost. Mon., p. 142, figs. 110-112. *Sphaerocarpus utricularis* Bull. Champ., ii. 128 (1791). *Trichia coerulea* Trentep. in Roth Catal. Bot., i. 229 (1797)? *T. utricularis* DC. Fl. Fr., 251 (1805). *T. rubiformis* Purt. in Brit. Pl. of Midl. Count., iii. 291, t. 37 (1821) *non* Pers. *Physarum ovoideum* Schum. Enum. Pl. Saell., ii. 198 (1803). *P. hyalinum*  $\beta$ . *chalybaeum* Alb. & Schw. Consp. Fung., 92 (1805). *P. botryoides* Fr. Stirp. Femsj., 83 (1825). *P. botrytes* Somm. Fl. Lapp., 242 (1826). *Diderma papaverinum* Wallr. Fl. Crypt. Germ., 375 (1833). *Badhamia varia* Mass. Mon., 319 (1892) in part.

Pl. 4.—*a.* cluster of sporangia; *b.* fragment of capillitium with a cluster of spores and three free spores; *c.* cluster of spores; *d.* spore; (England).

This species differs from *B. capsulifera* in habitat, in having large plasmodia commonly producing some thousands of sporangia, and in the spores being brighter in colour, with coarser and less crowded spines, without the cluster of warts on one side. In cultivations carried on continuously for many years, the four varieties described in Rostafinski's Monograph have presented themselves. The capillitium varied both in form and in the amount of lime it contained; in some cases the threads were broad with wide expansions at the angles, in others they were narrow and but little widened at the angles; in some the lime was abundant, in others only a few scattered granules could be found. The degree of clustering of the spores varied in different growths though all were cultivated from one original gathering of plasmodium, but they were never free. In some specimens in the Strassburg collection the spores show but slight indication of clustering, in others this character is well marked.

*Hab.* Plasmodium extensively creeping over the bark of fallen trees, logs, etc., feeding on effused fungi, especially *Stereum hirsutum* and *Polyporus versicolor*.—Batheaston, Somerset (B.M. 103); Lyme Regis, Dorset (B.M. 1174); Glamis, Forfarshire (B.M. 149); France (Paris Herb.); Germany (Strassb. Herb.); Italy (K. 165); Portugal (B.M. 2066); Massachusetts (B.M. 1177).

5. *B. foliicola* Lister in Journ. Bot., xxxv. 209 (1897). Plasmodium orange. Sporangia subglobose, 0.5 to 1 mm. diam., iridescent-grey, sessile and crowded, or standing singly on slender pale yellowish-brown stalks 0.2 to 0.5 mm. long. Capillitium a network of slender strands with white lime deposits. Spores free, sometimes showing a slight tendency to adhere in loose clusters, violet-brown, minutely spinulose, 9 to 11  $\mu$  diam.—Torrend Flore des Myxomycètes, p. 210.\*

Pl. 11.—*a.* sporangia; *b.* capillitium and spores; *c.* spore; (England).

This species is not infrequent in this country, where it sometimes occurs in great profusion on turf, on heaps of old straw or dead leaves, or on twigs. From *B. utricularis*, to which it is very closely allied, it is distinguished by the simple stalks, the free and minutely spinulose spores, and by the difference of habitat; from *B. panicea* it differs in having orange plasmodium and rather rougher spores. The description of *B. microcarpa* Schroet. (in Cohn Crypt. Fl. Schlesien, iii. pt. i. 131, 1889) would apply to *B. foliicola* except that the spores are given as measuring only 7.5 to 9  $\mu$ ; in the absence of the type, however, we cannot be sure that this reference is correct.

*Hab.* On turf, straw, dead leaves or twigs.—Wanstead, Essex (B.M. 1695); France (B.M. 2067); Switzerland (B.M. 2070); Sweden (B.M. 2068); Portugal (B.M. 2069).

6. *B. magna* Peck in Rep. New York Mus., xxxi. 57 (1879). Plasmodium? Sporangia globose, 1 mm. diam., violet-grey, iridescent, clustered on long membranous yellowish slender branching stalks 4 mm. long or more; sporangium-wall with scanty deposits of lime. Capillitium as in *B. capsulifera* Berk. Spores purplish-black, very minutely spinulose with a paler smoother area of dehiscence, not clustered, 9 to 10  $\mu$  diam.—*Dictydium magnum* Peck l.c., xxiv. 84 (1872). *B. varia* Mass. Mon., 319 (in part).

Pl. 9.—*a.* sporangia (Vermont, N. York; Peck's type); *b.* spores.

This species has been recorded hitherto from America only.

*Hab.* On dead wood.—Maine (B.M. 1585); Philadelphia (B.M. 2071).

7. *B. nitens* Berk. in Trans. Linn. Soc., xxi. 153 (1852). Plasmodium yellow. Sporangia sessile, subglobose, gregarious or clustered, about 1 mm. diam., sometimes forming plasmodiocarps, golden-yellow, rugose, or greenish with yellow warts and ridges; sporangium-wall membranous, with included clusters of yellow lime-granules. Capillitium yellow or orange, a coarse network of rugged bands, rarely contracted to form short hyaline threads connecting branched lime-knots; deposits of lime usually dense, sometimes scanty. Spores purple-brown, in close clusters of 6 to 10, minutely spinulose,

\* Extrait de la Broteria, Ser. Bot., vi. (1907), vii. (1908), viii. (1909).

coarsely warted on the outer third, sometimes nearly free and less strongly warted on one side, 10 to 13  $\mu$  diam.—Rost. Mon., App. p. 3; Mass. Mon., 324. *B. pallida* Berk. l.c. *B. fulvella* Berk. l.c., 154? *B. inaurata* Currey in Trans. Linn. Soc., xxiv. 156 (1863). *B. Alexandrowiczii* Rost. Mon., p. 146 (1875). *B. decipiens* Lister Mycetozoa, 32 (1894), in part. *Didymium reticulatum* Berk. & Br. in Journ. Linn. Soc., xv. 83 (1876). *Lepidoderma reticulatum* Mass. Mon., 252 (1892).

Pl. 5.—*a. b.* sporangia; *c.* capillitium attached to fragment of sporangium-wall and three clusters of spores; *d.* spore; (England).

Examination of the type specimens of *B. nitens* and *B. pallida* from East Bergholt, Essex (Kew 1218, 1235), and of *B. inaurata* from Carlisle (B.M. 151), shows that they are all the same species, with yellow sporangium-walls and closely clustered spores coarsely warted on one side. The type of *Didymium reticulatum* Berk. & Br. from Ceylon (B.M. 574) has few spores remaining, but these are loosely clustered; the specimen is therefore placed under *B. nitens*.

*Hab.* On dead wood.—Lyme Regis, Dorset (B.M. 1179); Caddington, Beds (B.M. 1178); Poland (Strassb. Herb.); Ceylon (B.M. 574); Antigua (B.M. 1640); Dominica (B.M. 1640A).

8. *B. versicolor* Lister in Journ. Bot., xxxix. 81, tab. 419, 2*a* to *e* (1901). Plasmodium? Sporangia subglobose, sessile, minute, 0.3 to 0.5 mm. diam., scattered or in small clusters, grey or flesh-coloured, somewhat rugose; sporangium-wall membranous with scanty deposits of lime-granules. Capillitium a network of broad or narrow strands charged throughout with lime-granules, white or apricot coloured. Spores ovoid,  $10 \times 8$  to  $12 \times 9 \mu$ , arranged in clusters of 10 to 40, forming hollow spheres, dull purple and minutely warted at the broad end, nearly colourless and smooth elsewhere.—Sturgis in Colorado Coll. Publ., Sci. Ser. xii. 13 (1907).

Pl. 6.—*a.* sporangia; *b.* capillitium and clusters of spores with some free spores; *c.* spore; (Scotland).

This minute species appears to be allied on the one hand to *B. capsulifera*, and on the other to *B. nitens*. As yet it has been recorded only from two widely separated localities. The Rev. W. Cran has found it on about a dozen occasions near Rhynie, Aberdeenshire, where it occurred on living trees at a height of five or six feet from the ground; in 1906 the same form was discovered by Mr. E. Bethel on the bark of fallen trunks of "box-elder" (*Negundo*) near Boulder, Colorado.

*Hab.* On bark and lichen.—Aberdeenshire (B.M. 1759); Colorado (B.M. 2072).

9. *B. decipiens* Berk. in Grev., ii. 66 (1873). Plasmodium yellow? Sporangia sessile, subglobose, or forming curved plasmodiocarps 0.3 to 0.7 mm. diam., scattered, rugose or nearly smooth, yellow or orange; sporangium-wall membranous with included clusters of yellow lime-granules. Columella

none. Capillitium yellow or pale orange, a coarse network densely charged throughout with lime-granules, or formed of large angular and branching lime-knots with few connecting hyaline threads. Spores free, violet-brown, spinulose, often rather paler and smoother on one side, 10 to 13  $\mu$  diam.—Macbr. N. Am. Slime Moulds, 63. *Physarum decipiens* Curt. in Amer. Journ. Sci., vi. 352 (1848). *P. chrysotrichum* Berk. & Curt. in Grev., ii. 66 (1873). *Badhamia chrysotricha* Rost. Mon., App. p. 4 (1876).

Pl. 7.—*a.* sporangia (South Carolina; *legit* Curtis); *b.* capillitium and spores with fragment of sporangium-wall; *c.* spore.

A portion of the type from South Carolina in the British Museum (B.M. 994) has little left for identification, yet some spores and a fragment of sporangium-wall which were scraped off are identical with a good specimen in the Strassb. Herb. sent by Prof. Farlow from Curtis's original gathering. *B. decipiens* is distinguished from *B. nitens* by having free spores. From *Physarum auriscalpium* Cke., the stouter forms of which it closely resembles, the present species differs in the absence of a stalk, in the more complete *Badhamia* character of the capillitium, and usually in the darker spores. MM. Pavillard and Lagarde describe the young sporangia as being first milk-white, then saffron-yellow, then intense green from the purple spores showing through the moist walls; finally, when dry, the sporangia assume an orange-yellow colour (*see* Bull. Soc. Myc. Fr., xix. fasc. 2, 87 (1903).

*Hab.* On dead wood.—Yorks (B.M. slide); Sweden (Herb. R. E. Fries); Montpellier (B.M. 2073); Hartz Mountains (B.M. 2074); South Carolina (B.M. 994).

10. **B. macrocarpa** Rost. Mon., p. 143, figs. 118, 120, 121 (1875). Plasmodium white.\* Sporangia sessile or stalked, subglobose, aggregated or gregarious, 0.5 to 1 mm. diam., greyish-white, rugose; sporangium-wall membranous, varying in the amount of included lime-deposits. Stalk when present firm, about 0.7 mm. long, 0.03 to 0.1 mm. diam., furrowed, yellow or brown. Capillitium an irregular network formed of broad, branching white lime-knots, with narrower connecting strands, charged throughout with granules of lime. Spores dark purple-brown, minutely and closely spinulose all over, not clustered, 11 to 15  $\mu$  diam.—Mass. Mon., 317; Macbr. N. Am. Slime-Moulds, 69. *Physarum macrocarpon* Ces. in Rabenh. Fungi Eur., no. 1968 (1854), & in Flora, xxxviii. 271 (1855).

Pl. 8.—*a.* sporangia; *b.* capillitium and spores; *c.* spore; (England).

\* ]

The American specimens of this species appear to be, as a rule, smaller than the European gatherings, and the stalks, when present, are more slender.

*Hab.* On dead wood.—Flitwick, Beds (B.M. 1183); Staffordshire (B.M. 1184); Holland (Leyden Herb.); Franco (K. 183); Berlin (B.M. 434); Poland (Strassb. Herb.); Italy (B.M. 1792); Philadelphia (B.M. 1185); Colorado (B.M. 2076); Japan (B.M. 2075).

\* Constantineanu describes the colour of the plasmodium as yellow (Ann. Myc., iv. 512).

11. **B. affinis** Rost. Mon., p. 143 (1873). Plasmodium ? Sporangia hemispherical, somewhat depressed, flattened or umbilicate beneath, about 0.5 mm. diam., greyish-white, rugulose, gregarious, stalked or sessile. Stalk varying from 0.1 to 0.7 mm. in length, black, or black below and white above, furrowed. Capillitium as in *B. macrocarpa*. Spores violet-brown, minutely spinulose, 12 to 15  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 66.

The type specimen from Chili appears to be lost; Prof. Macbride, however, finds North American gatherings agreeing so perfectly with Rostafinski's description, that he has felt justified in naming them *B. affinis*. This species appears to hold an intermediate position between *B. macrocarpa* and *B. orbiculata*, differing from the former in the more depressed sporangia and paler spores, and from the latter in the sporangia being smaller and less discoid in shape. Specimens corresponding closely with one named *B. affinis* by Prof. Macbride have been obtained several times in Japan by Mr. Kumagusu Minakata, whose investigations have added so much to our knowledge of the Mycetozoa of that country. Sporangia similar to those from Japan have recently been found by the Rev. W. Cran on moss growing on wood in Aberdeenshire.

*Hab.* On bark and moss.—Pennsylvania (B.M. 2077); Kii, Japan (B.M. 2078); Aberdeenshire (B.M. slide).

12. **B. orbiculata** Rex in Proc. Acad. Nat. Sci. Phil. 1893, 372. Plasmodium cream-coloured. Sporangia scattered, orbicular, discoidal, or irregularly elongated, flattened or concave above, about 0.7 mm. diam., greyish-white, shortly stalked or sessile, sometimes forming extended plasmodiocarps; sporangium-wall membranous, with scanty deposits of lime granules. Stalk black, furrowed, 0.1 to 0.3 mm. high. Capillitium a network of branched strands, charged with lime-granules, sometimes uniting to form a central calcareous plate, or of almost simple rod-like tubes attached above and below to the sporangium-wall. Spores violet-brown, minutely warted, 12 to 15  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 66. *B. macrocarpa* Lister Mycetozoa, 34, in part.

Pl. 8.—*d.* sporangia; *e. f.* spores; (Philadelphia).

This species, though closely allied to *B. macrocarpa*, appears to maintain its characters well. It has now been found repeatedly in many of the States of North America, in the West Indies, and in Japan.

*Hab.* On dead wood.—Colorado (B.M. 2057); Dominica (B.M. 1642); Japan (B.M. 2079).

13. **B. panicea** Rost. in Fuckel Symb. Myc., Nachtr. 2, p. 71 (1873). Plasmodium white. Sporangia subglobose, 0.4 to 1.2 mm. diam., scattered, or closely aggregated and angled by mutual pressure, white or cinereous, sessile, often seated on a dark red hypothallus, rarely with short dark red stalks; sporangium-wall membranous, with included

deposits of lime-granules in dense clusters forming raised warts or veins. Capillitium white, a profuse network of broad or narrow bands, charged with granules of lime, often densely confluent at the base and forming an ivory-white columella, sometimes with a few hyaline connecting threads. Spores violet-brown, very minutely warted, not clustered,  $11\ \mu$  diam.—Rost. Mon., p. 144, figs. 114, 116; Mass. Mon., 318; Macbr. N. Am. Slime-Moulds, 64. *Physarum paniceum* Fr. Syst. Myc., iii. 141 (1829). *Badhamia verna*, Rost. l.c. p. 145, in part.

Pl. 10.—*a.* sporangia; *b.* capillitium and spores; *c.* spore; (England).

When, as occasionally happens, the sporangia are shortly stalked, this species shows a marked affinity to *Physarum pusillum* (q.v. 64). The specimen from Freiburg named by Rostafinski *B. verna* (B.M. 1189) is a form of *B. panicea* with scanty lime.

*Hab.* On bark and wood; frequent in Britain.—Batheaston, Somerset (B.M. 77); Lyme Regis, Dorset (B.M. 1186); Cambridge (B.M. 1187); France (B.M. 425); Germany (B.M. 424); Switzerland (Zürich Herb.); Sweden (B.M. 2080); Portugal (B.M. 2081); Colorado (B.M. 2082).

14. **B. ovispora** Racib. in Rozpr. Mat.-Przyr. Akad. Krak., xii. 72, tab. 4, fig. 2 (1884). Plasmodium? Sporangia sessile, white or ochraceous, smooth or rugose, hemispherical, 0.5 mm. diam., or forming irregular and often branching plasmodiocarps, crowded or scattered; sporangium-wall thick but friable from the dense deposits of lime granules. Capillitium white, fragile, consisting of an irregular network of tubes filled with loosely adhering lime-granules, often uniting to form a columella at the base of the sporangium. Spores free, purple-brown, ellipsoid,  $10 \times 8$  to  $16 \times 10\ \mu$ , smooth, traversed lengthwise by a low ridge or fold marking the line of dehiscence.

Pl. 12.—*a.* sporangia; *b.* capillitium and spores; *c.* spore; (Bedfordshire).

This minute species has been found repeatedly, and in some years very abundantly, on heaps of old straw during the months of August and September in the counties of Bedfordshire and Hertfordshire since 1897 when the first British gathering was made by Mr. James Saunders.

*Hab.* On branches of *Populus canescens* DC., and on old straw.—Stopseley, Beds (B.M. 1694); Bushey, Herts (B.M. 2083); Bohemia (B.M. slide).

15. **B. lilacina** Rost. Versuch, 10 (1873). Plasmodium bright yellow. Sporangia subglobose, about 0.5 mm. diam., sessile, rarely shortly stalked, gregarious, or crowded and angled by mutual pressure, smooth, flesh-colour or whitish; sporangium-wall opaque from included deposits of lime. Capillitium flesh-coloured or nearly white,—a rugged network with large knots of irregular shape densely charged with lime-granules, often confluent in the centre and forming a pseudo-columella. Spores dark purple-brown, rough or reticulated with prominent



and confluent warts and ridges, 10 to 15  $\mu$  diam.—Rost. Mon., p. 145, figs. 108, 109; Macbr. N. Am. Slime-Moulds, 65. *Physarum lilacinum* Fr. Syst. Myc., iii. 141 (1829). *P. concinnum* Mass. Mon., 308 (1892). *Craterium lilacinum* Mass. l.c. 271.

Pl. 13.—*a.* sporangia; *b.* capillitium and spores; *c.* spore; (Pilmoor, Yorks).

Prof. Macbride describes this species as common in the eastern U.S.A. In Britain it appears to be less frequent, though the small pink sporangia when maturing among grass and moss on open ground may easily escape detection.

*Hab.* On dead wood, twigs, *Sphagnum*, etc.—Pilmoor, Yorks (B.M. 1190); Arisaig, Scotland (B.M. 2084); Germany (B.M. 488); New York (B.M. 1191).

16. *B. rubiginosa* Rost. Mon., App. p. 5, fig. 115 (1876). Plasmodium bright yellow. Sporangia obovoid, stalked, rarely sessile, 0.5 mm. broad, rufous, or purplish-brown, usually paler above, the upper part of the wall breaking away in fragments from the more persistent lower part; sporangium-wall purplish, membranous, more or less charged with granules of lime. Stalk cylindrical or widening at the base, usually about the length of the sporangium, smooth, purplish-brown, continued within the sporangium to more than half its height as a pale clavate or cylindrical columella. Capillitium a white or pale rufous rugged network, usually densely charged with lime-granules, spreading from all parts of the columella to the sporangium-wall, sometimes with a few hyaline connecting threads. Spores dark purplish-brown, 13.5  $\mu$ . minutely spinulose.—Macbr. N. Am. Slime-Moulds, 70. *Physarum rubiginosum* Chev. Fl. Paris, i. 338 (1826). *Scyphium rubiginosum* Rost. Mon., p. 148 (1875). *Craterium rubiginosum* Mass. Mon., 270 (1892). *Didymium Curtisii* Berk. in Grev., ii. 65 (1873). *Badhamia Curtisii* Rost. Mon., App. p. 5. *B. subaquila* Macbr. N. Am. Slime-Moulds, 64. *Craterium Curtisii* Mass. Mon., 272. *Craterium obovatum* Peck in Rep. New York Mus., xxvi. 75 (1874).

Var. 1.—*dictyospora* Lister: sporangia obovoid; spores marked with prominent more or less confluent warts, or reticulated.—*Badhamia dictyospora* Rost. Mon., App. p. 4. *Craterium dictyospermum* Mass. Mon., 270.

Var. 2.—*globosa* Lister in Journ. Bot., xlii. 130 (1904): sporangia subglobose, 0.7 mm. diam., purplish-grey; stalk dark brown, 0.5 to 1 mm. long; columella dark brown, clavate; spores strongly reticulated and warted.—*Diderma Hookeri* Berk. in Hooker Fl. Nov. Zel., pt. 2, 191 (1855)? *Lumproderma Hookeri* Rost. Mon., App. p. 24 (1876)? *Diachaea Hookeri* Mass. l.c. 260? *Chondrioderma Hookeri* Lister Mycetozoa, 85 (1894)?

Pl. 14.—*a.* sporangia; *b.* spore; (Philadelphia); *c.* sporangia of var. *dictyospora*; *d. e.* capillitium and spores of same; (Epping Forest); *f.* sporangia of var. *globosa*; *g.* spore of same; (N. Wales).

The type of *Didymium Curtisii* Berk. from South Carolina (B.M. 406) differs from typical *B. rubiginosa* only in being sessile or shortly stalked. The type of *B. subaquila* Macbr. from Maine (B.M. 3184) is similar, but has completely sessile sporangia on a stout purplish hypothallus; in both British and American gatherings of *B. rubiginosa*, however, the length of the stalk is subject to great variation, and the sessile character alone would not appear to constitute a specific difference. The typical form of the present species with minutely spinulose spores is very abundant in the United States, but does not appear to be common in Europe, and has not yet been obtained from the British Isles. The var. *dictyospora* has been found several times in England and Scotland, and also in Germany and Portugal. The var. *globosa* has been obtained from various parts of England, from Wales, and Ireland, always occurring on moss and ferns growing on wet rocks. The resemblance which these gatherings bear to the unsatisfactory type of *Diderma Hookeri* Berk. (K. 1559), from New Zealand, is very striking. In the latter specimen the sporangia are studded over the leaves of a species of *Hymenophyllum*, and were evidently much weathered at the time of collection; hardly any spores remain, and even these may possibly have been introduced from external sources; the few slender bases of capillitium threads springing from the stout columella strongly resemble those about the columella of *B. rubiginosa* var. *globosa*, in some forms of which the capillitium is often very slender and contains little or no lime. Although complete proof of the identity of *Diderma Hookeri* and *B. rubiginosa* var. *globosa* cannot perhaps now be obtained, the probability that they are the same form is strong. (See Journ. Bot., xliii. 151, 1905.)

*Hab.* In woods on fallen brushwood, etc.; var. *globosa* on moss on wet rocks.—Paris (B.M. 2105); Philadelphia (B.M. 1194); Maine (B.M. 1587); Iowa (B.M. 815); South Carolina (B.M. 406); var. *dictyospora*, Leighton, Beds (B.M. 1192); Appin, Argyllshire (K. 193); North Germany (B.M. 2218); Portugal (B.M. 2085); var. *globosa*, Cheshire (B.M. 1036); North Wales (B.M. 1704); Galway (B.M. 2086).

#### SPECIES REJECTED AND DOUBTFUL.

*Badhamia fulvescens* Cooke is probably a fungus and to be referred to the *Perisporiacei*, *fide* Dr. M. C. Cooke.

*B. irregularis* Cooke & Ellis in Grev., v. 89 (1877), from New Jersey, is described as having scattered sessile subglobose or confluent sporangia, blackish-brown in colour, with rough, blackish spores 10  $\mu$  diam. This account is too brief for instruction.

**Genus 3.—PHYSARUM** Persoon in Usteri Ann. Bot., xv. 5 (1795). Sporangia stalked, sessile, or forming plasmodiocarps; sporangium-wall either single, or consisting of two more or less separable layers, and containing minute rounded lime-granules distributed in loose or dense clusters or compacted into a crust; the lime always included and not in superficial crystals. Stalk at first tubular (solid in *P. penetrans*); the tube may become contracted and its walls be wrinkled with longitudinal folds and translucent or

opaque with deposits of lime in the wall-substance ; or the tube may be filled at the base or throughout with refuse matter discharged from the plasmodium, or with deposits of lime, giving the stalk a brittle structure with a chalk-like section. Capillitium forming a network of hyaline threads with vesicular expansions containing deposits of lime (lime-knots).

The genus *Tilmadoche* is described by Rostafinski (Mon., p. 126) as differing from *Physarum* in the capillitium forking repeatedly at a narrow angle, and being provided with few and small lime-knots. These characters are too inconstant to be of value in classification. In *P. nutans* Pers., which from its abundance affords ample facility for study, we not infrequently observe in a growth from one plasmodium some sporangia with capillitium characteristic of *Physarum* and others of *Tilmadoche*. *P. polycephalum* Schwein. (syn. *T. gyrocephala* Rost.) frequently has capillitium with large lime-knots and broad membranous expansions. *T. oblonga* Rost. and *T. hians* Rost. are now included under *Physarella oblonga* (Berk. & Curt.) Morgan, a species distinguished from its allies by well-marked characters of shape and capillitium that fully entitle it to a position in a separate genus. For these reasons the genus *Tilmadoche* is not retained.

## KEY TO THE SPECIES OF *PHYSARUM*.

### A. Sporangia stalked (occasional sessile forms) :—

#### a. Stalks charged with lime throughout—

##### a. Capillitium lax—

Stalk white ; sporangia grey ; lime-knots large, white ;  
columella none. 1. *P. leucopus*

Stalk white, rarely rufous ; sporangia tawny,  
globose ; columella conical. 2. *P. melleum*

Stalk white ; sporangia sulphur-yellow ; columella  
none. 3. *P. sulphureum*

Stalk olive or yellowish, short or absent ; sporangia  
olive or yellow, globose, ovoid or forming plas-  
modiocarps ; columella none. 4. *P. variabile*

Stalk and sporangium yellow or orange ; columella  
large, hemispherical. 5. *P. luteo-album*

##### b. Capillitium dense, persistent—

Stalk white or brownish below ; sporangium white ;  
lime-knots small, white. 6. *P. globuliferum*

Stalk, sporangium, and lime-knots red.  
7. *P. pulchripes*

Stalk, sporangium, and lime-knots mouse-brown.  
8. *P. murinum*

Stalk, sporangium, and lime-knots purple.

9. *P. pulcherrimum*

Stalk, sporangium, and lime-knots yellow; robust.

10. *P. citrinum*

Stalk, sporangium, and lime-knots straw-coloured;  
slender.

11. *P. tenerum*

Stalk and sporangium white; capillitium with a  
central ball of lime.

12. *P. compactum*

Stalk ochraceous, often absent; sporangium white,  
ovoid or cylindrical, with a long pseudo-columella.

13. *P. mutabile*

B. Stalks without lime, or with deposits in the wall only—  
(See also 13).

a. Lime-knots purple-red; sporangium rose-red.

14. *P. roseum*

β. Lime-knots and sporangium violet-purple.

15. *P. Newtoni*

γ. Lime-knots orange; sporangium glossy, mottled blue  
and red; stalk red or orange.

16. *P. psittacinum*

δ. Lime-knots orange; sporangium bronze; stalk black;  
spores reticulated.

17. *P. dictyospermum*

ε. Lime-knots yellow or orange; sporangia yellow,  
orange, or grey—

Sporangia subglobose or lenticular, on slender stalks;  
capillitium lax; lime-knots fusiform.

18. *P. viride*

Sporangia subglobose on stout stalks; lime-knots  
pale yellow, angular or branching.

19. *P. Bethelii*

Sporangia contorted, stalked, usually clustered;  
capillitium lax; lime-knots fusiform.

20. *P. polycephalum*

Sporangia subglobose, yellow or iridescent-bronze;  
stalks red-brown; slender capillitium persistent;  
lime-knots angular, small.

21. *P. flavicomum*

Sporangia globose on slender yellow stalks; lime-  
knots angular.

22. *P. galbeum*

Sporangia subglobose or obovoid, yellow with a  
reddish base; lime-knots angular, large.

23. *P. Maydis*

Sporangia subglobose ; stalks brown and short, or absent ; lime-knots large and branching.

24. *P. auriscalpium*

Sporangia subglobose, pale yellow ; stalks when present membranous.

25. *P. fulvum*

Stalk penetrating the sporangium for four-fifths of its height.

26. *P. penetrans*

ζ. Lime-knots white, sporangia yellow or brown—

Sporangia subglobose, yellow, rugose ; stalks red.

27. *P. citrinellum*

Sporangia subglobose, pale yellow ; stalks flesh-coloured.

28. *P. carneum*

Sporangia brown, smooth, shining ; stalks when present red.

29. *P. brunneolum*

η. Lime-knots white ; sporangia grey or white—

\* Stalk free from refuse matter—

Stalk straw-coloured ; sporangia globose ; capillitium with a central ball of lime.

30. *P. nucleatum*

Stalk straw-coloured, slender ; sporangia compressed ; spores marked with patches of warts.

31. *P. straminipes*

Stalk red-brown ; sporangia globose, white.

32. *P. pusillum*

Stalk white, membranous, short or absent ; sporangia ovoid, or subglobose (and then sessile), without pseudo-columella.

33. *P. didermoides*

\*\* Stalk containing refuse matter—

Stalk buff, black, or white ; sporangia subglobose ; spores brownish-violet.

34. *P. nutans*

Stalk white or yellowish, sporangia discoid, often umbilicate above, spores brownish-violet.

35. *P. javanicum*

Stalk black, or black below, white above ; sporangia ovoid or subglobose, usually with a long columella.

36. *P. crateriforme*

Stalk black, buff, or white, stout ; sporangia compressed, lime-knots rounded ; spores dark purple-brown.

37. *P. compressum*

Stalk brown or white ; sporangia subglobose ; lime-knots angular ; spores dark purple-brown.

38. *P. connatum*

Stalk yellowish or dark, slender; sporangia compressed and lobed, often clustered (smaller than *P. compressum*, to which it is very nearly allied).

39. *P. reniforme*

*B.* Sporangia sessile, never stalked—(for occasional sessile forms, see 4, 8, 13, 24, 25, 29, 31, 33, 34, 37).

*A.* Lime-knots white—

*a.* Sporangium-wall single—

Sporangia subglobose or forming plasmodiocarps, white or grey; spores pale brownish-violet, 7–8  $\mu$  diam.

40. *P. cinereum*

Sporangia subglobose, heaped, the walls with scanty or no lime deposits, spores brownish-violet, 10–11  $\mu$  diam.

41. *P. atrum*

Sporangia subglobose or forming plasmodiocarps; white or grey, spores dark violet-brown, 9–11  $\mu$ , diam.

42. *P. vernum*

Sporangia much compressed, forming rosettes or net-like plasmodiocarps; lime-knots fusiform.

43. *P. gyrosum*

Sporangia crowded, chestnut-brown.

44. *P. Gulielmae*

*b.* Sporangium-wall double—

\* Sporangia scattered, forming plasmodiocarps—

Plasmodiocarps sinuous, compressed, white; spores marked with strong ridges and spines, brownish purple.

45. *P. echinosporum*

Plasmodiocarps sinuous, compressed, white or buff; inner wall fragile, colourless; spores purple-brown, spinulose.

46. *P. sinuosum*

Plasmodiocarps sinuous, buff or brown, marked with pale lines of dehiscence; spores pale brownish violet, nearly smooth.

47. *P. bogoriense*

Plasmodiocarps white, usually compressed; inner wall purplish, sub-persistent; spores dark purplish brown, spinulose.

48. *P. bitectum*

\*\* Sporangia crowded, reniform or subglobose—

Sporangia white, subglobose, outer wall shell-like.

49. *P. testaceum*

Sporangia yellow; spores dark, rough, 10–14  $\mu$ .

50. *P. contextum*

Sporangia pale yellow ; spores pale, nearly smooth,  
8-10  $\mu$ . 51. *P. conglomeratum*

B. Lime-knots yellow, red, or brown—

Slender plasmodiocarps and large branching lime-knots yellow. 52. *P. Serpula*

Plasmodiocarps and lime-knots brown. 53. *P. aeneum*

Sporangia red or brownish buff ; lime-knots large, angular, orange-red or red-brown.

54. *P. rubiginosum*

Sporangia red ; lime-knots rounded, yellow, usually with red centres. 55. *P. lateritium*

Sporangia yellow or orange with single walls ; lime-knots angular, yellow. 56. *P. virescens*

Plasmodiocarps stout, yellow or buff, with double walls ; lime-knots large, yellow, angular.

57. *P. alpinum*

1. ***P. leucopus*** Link in Mag. Ges. Nat. Fr. Berl., iii. 27 (1809). Plasmodium opaque-white. Total height about 1 mm. Sporangia globose, greyish-white or glaucous, 0.5 mm. diam., gregarious or clustered, stalked, rarely almost sessile ; sporangium-wall delicately membranous, containing scattered or clustered white globular lime-granules. Stalk white, stout, 0.15 to 0.2 mm. thick, with a few shallow longitudinal furrows, erect, rigid, brittle, somewhat narrowing upwards, chalk-white in section to the base, rising from a more or less developed white hypothallus, enclosing no refuse matter. Columella none. Capillitium consisting of delicate branching hyaline threads connecting large irregular white lime-knots, which are 10 to 50  $\mu$  broad and filled with globular lime-granules 1 to 1.5  $\mu$  diam. Spores violet-brown, minutely spinulose, 7 to 10  $\mu$  diam.—Rost. Mon., p. 101 ; Mass. Mon., 287, in part ; Macbr. N. Am. Slime-Moulds, 48. *P. bullatum* Link l.c. ; Ditm. in Sturm Deutsch. Fl., Pilze, 45, t. 22. *Didymium leucopus* Fr. Syst. Myc., iii. 121 (1829).

Pl. 15.—a. sporangia ; b. capillitium with fragment of sporangium-wall and spores c. spore ; (England).

The snow-white stalk, which is chalk-white in section to the base, distinguishes *P. leucopus* from *P. nutans*, where the stalk almost always contains dark refuse matter, while the lax capillitium, with large lime-knots and the large lime-granules in the knots and sporangium-wall, separate it from *P. globuliferum*. Sporangia sometimes occur having more slender buff or pale brown stalks in company with others having the usual white stalks.

**Hab.** On dead leaves, moss, etc.—Batheaston, Somerset (B.M. 48) ; Lyme Regis, Dorset (B.M. 1196) ; France (B.M. 3185) ; Sweden (B.M. 2088) ; Germany (B.M. 2089) ; Portugal (B.M. 2090) ; Java (B.M. 2091) ; Ohio (B.M. 1198) ; New Granada (Paris Herb.).

2. *P. melleum* Mass. Mon., 278 (1892). Plasmodium yellow. Total height 0·8 mm. Sporangia globose, stalked, erect, yellow or brownish-yellow, 0·5 mm. diam.; sporangium-wall membranous, often wrinkled, persistent at the base, yellowish, with minute yellow lime granules sparsely distributed. Stalk white, buff, or rufous, stout, opaque, with few shallow furrows, chalky in section. Columella short, conical. Capillitium consisting of irregularly-branching delicate hyaline threads, sometimes expanded at the axils, with lime-knots white or yellowish, various in shape and size, mostly large and angled. Spores violet-brown, almost smooth, 7 to 8  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 47. *Didymium melleum* Berk. & Br. in Journ. Linn. Soc., xiv. 83 (1873). *Physarum Schumacheri*, var.  $\beta$  *melleum* Rost. Mon., App. p. 7. *P. Kalchbrenneri* Mass. Mon., 297. *P. rubropunctatum* Pat. in Bull. Soc. Myc. Fr., ix. 143 (1893)? *Didymium chrysopeplum* Berk. & Curt. in Grev., ii. 53 (1873). *Cytidium melleum* Morg. Myx. Miami Valley, 83 (1896).

Pl. 23.—*a.* sporangia; *b.* capillitium and spores; *c.* spore; (Philadelphia).

Common in the United States, and apparently abundant throughout the tropics; hitherto the only European records known are those made by Dr. C. Torrend, who has several times gathered the species in Portugal. Mr. Petch describes the plasmodium as being watery ochraceous-yellow (in Ann. Perad., iv. 329).

*Hab.* On dead wood, leaves, etc.—Portugal (B.M. 2092); Cape (K. 347); Ceylon (B.M. 411); Borneo (B.M. 1257); Java (B.M. 2093); Japan (B.M. 1996); Philippine Islands (B.M. 2050); Philadelphia (B.M. 1210); Ohio (B.M. 1211); Iowa (B.M. 1018); Antigua (B.M. 1645); Brazil (B.M. 2094).

3. *P. sulphureum* Alb. & Schw. Consp. Fung., 93, tab. 6, fig. 1 (1805). Plasmodium? Sporangia subglobose, ruguloso-squamulose, sulphur-yellow, gregarious, 0·6 to 0·8 mm. diam., stalked; sporangium-wall membranous, with crowded clusters of yellow lime-granules. Stalk stout, white, dirty white or yellowish, 0·1 to 0·3 mm. high, furrowed, densely charged with lime within. Columella none. Capillitium with abundant large, irregular, often branching white lime-knots, and rather short connecting threads. Spores violet-brown, spinulose, 9 to 11  $\mu$  diam.—Rost. Mon., p. 101. *P. flavum* Fr. Symb. Gast., 22 (1818); Rost. l.c., 100. *P. lepidodermoides* Blytt in Bidr. Norg., Sop. iii. 4 (1892)? *Craterium flavum* Fr. Summ. Veg. Scand., 454 (1849).

Pl. 65.—*a.* sporangia; *b.* capillitium and spores, with fragment of sporangium-wall; *c.* spore; (Sweden).

Specimens gathered by Dr. R. E. Fries from near Upsala correspond exactly with the illustration of the type in Consp. Fung., l.c. This species is closely related to *P. variabile* Rex, from the stalked forms of which it is distinguished by the more globose sporangia and the rather



larger and darker spores. The graphic description of *P. flavum* Fr., with its rugose but glossy (*glaberrima*) yellow sporangia and short yellowish-white furrowed stalks, applies well to the present species. In *Systema Mycologium*, p. 135, Fries places *P. flavum* next after *P. sulphureum*; the distinctions he makes between the two species are the bright yellow rather than sulphur-coloured sporangia and yellow not white stalks of *P. flavum*; sporangia showing varying shades of brightness, with white or yellowish stalks, may however occur in a single group of *P. sulphureum*. The type of *P. lepidodermoides* Blytt from Rollag, Telemarken, on moss (B. M. slide), has subglobose stalked sporangia, 0.7 to 0.8 mm. diam.; the sporangium-wall breaks up into shining convex pale brown scales, densely charged with deposits of lime; there is no columella; the stalks are 0.5 mm. high, stout, furrowed, broader at the base, cream-white, without lime-deposits; the capillitium consists of large irregular shrunken whitish lime-knots connected by branching hyaline threads; the spores are purple-brown, spinulose, 9 to 11  $\mu$  diam.; the scales of the sporangium-wall and the shrunken lime-knots suggest that this is not a perfect development; probably it is a form of *P. sulphureum*, in which we have met with some sporangia having almost no lime in the stalk associated with others whose stalks are rich in lime. *P. lepidodermoides* bears some resemblance to *P. citrinellum* Peck, but the stalks are cream-white, not orange-red as in the latter species.

*Hab.* On dead leaves.—Upsala (B.M. 2095); Brandenburg (B.M. 2096).

4. *P. variable* Rex in Proc. Acad. Nat. Sci. Phil., 1893, 371. Plasmodium? Total height about 1 mm. Sporangia gregarious, piriform, ovoid, or subglobose, 0.4 to 0.5 mm. broad, stalked or sessile, rugose, often somewhat glossy, yellowish-olive; sporangium-wall membranous, with dense innate deposits of yellowish lime-granules. Stalk stout, conical, furrowed, 0.4 mm. high or less, yellowish-brown, densely charged with white lime-granules. Columella none. Capillitium a close network of slender hyaline threads with membranous expansions at the axils of the branches; lime-knots numerous, irregularly branching, many large and confluent, white or pale yellow. Spores brownish-violet, spinulose, 9 to 10  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 39.

Var. *sessile* Lister in Journ. Bot., xxxvi. 114 (1898): sporangia sessile, forming curved branching plasmodiocarps, yellow or bright orange, occasionally almost white.—Petch in Ann. Perad., iv. 329.

Pl. 21.—*a.* sporangia; *b.* capillitium and spores; *c.* spore; (New York).

Pl. 22.—var. *sessile*: *a.* sporangia (Philadelphia); *b.* sporangia (Antigua); *c.* capillitium and spores; *d.* spore.

*Hab.* On dead leaves.—Banff, Canada (B.M. 3189); Iowa (B.M. 812); New York (B.M. slide); Venezuela (B.M. slide); var. *sessile*—Antigua (B.M. 1644); Philadelphia (B.M. 2097); South Carolina (B.M. 991); Ceylon (B.M. 2098).

5. *P. luteo-album* Lister in Journ. Bot., xlii. 130, t. 459, fig. 2 (1904). Plasmodium ? Sporangia stalked, gregarious, subglobose, about 1 mm. broad, 0.7 mm. high, yellow shading into white, deep orange or olivaceous, smooth or rugulose ; sporangium-wall pale yellow or orange, with dense or scanty deposits of yellow lime-granules. Stalk stout, smooth, 0.5 to 1 mm. long, 0.2 mm. thick, bright yellow or orange above, nearly white below, either cylindrical and densely charged with lime-granules throughout, or narrowed towards the base and the lime there in the form of crystalline nodules. Columella large, subglobose or shortly clavate, pale yellow or orange. Capillitium either of very slender pale yellow threads, branching at acute angles and anastomosing, or of broad yellow simple or forked strands, persistent after the dispersion of the spores ; lime-knots few, small, yellow, linear or fusiform. Spores purple-brown, strongly spinulose, 10 to 12  $\mu$  diam.

Pl. 24.—*a.* sporangia ; *b.* capillitium and spores ; *c.* spore ; (Ventimiglia).

This well-marked species was first gathered in January, 1903, by Miss Constance Pim, who found about twenty pale yellow sporangia on pine needles, in the gardens of Sir T. Hanbury, La Mortola, Ventimiglia. Since then a form agreeing in all essentials with the type, but with orange or olive-coloured sporangia, has been found in abundance on the shores of the Kolksee, E. Holstein, by Dr. H. Rönn, in an alder wood, in the winter of 1909-1910. The same form was obtained near Lyme Regis, in March, 1910, on dead alder and bramble leaves in a boggy copse. In these later gatherings the sporangia are either scattered or united in pairs ; the sporangium-walls have usually scanty deposits of lime, and readily fall away, leaving a collar-like rim round the base of the columella, and exposing the persistent brush of yellow capillitium ; the lime-knots are usually very slender, and often consist merely of a row of lime-granules enclosed in a thread of the capillitium ; the strongly spinulose spores are rather paler than in the La Mortola specimen (see *P. luteo-album* var. *aureum* Rönn in Schrift. Naturw. Ver. Schles.-Holst., xv. 51).

*Hab.* On pine needles.—Devon (B.M. 3187) ; Italy (B.M. 2099) ; Holstein (B.M. 3186).

6. *P. globuliferum* Pers. Syn., 175 (1801). Plasmodium ? Total height 1 to 1.5 mm. Sporangia gregarious, globose, stalked, erect, white, 0.5 mm. diam. ; sporangium-wall membranous, with crowded clusters of included lime-granules. Stalk white or pale buff, sometimes red-brown towards the base, 0.5 to 1 mm. long, 0.05 to 0.1 mm. thick, nearly smooth, brittle, chalky in section. Columella conical. Capillitium persistent, retaining the form of the sporangium after the dispersion of the spores, forming a close network of widely branching hyaline threads with numerous fusiform or rounded white lime-knots 10 to 20  $\mu$  diam. Spores violet-brown, almost smooth, 6 to 8  $\mu$  diam.—Rost. Mon., p. 98, fig. 86 ;

Mass. Mon., 297; Macbr. N. Am. Slime-Moulds, 45. *Sphaerocarpus globulifer* Bull. Champ., 134, t. 484, fig. 3 (1791). *Stemonitis globulifera* Gmel. Syst. Nat., ii. p. 1469 (1791). *Diderma globuliferum* Fries Syst. Myc., iii. 100 (1829). *Physarum Petersii* var. *Farlowii* Rost. Mon., App. p. 6 (1876). *P. albicans* Peck. in Rep. New York Mus., xxx. 50 (1878); Mass. l.c., 312. *Physarum columbinum* Macbr. in Bull. Nat. Hist. Iowa, ii. 384 (1893). *P. relatum* Morgan Myx. Miami Valley, 98 (1896). *P. delicatissimum* Speg. in Anal. Mus. Nac. Buen. Aires, vi. 199 (1899)? *Didymium subroseum* Peck l.c., xxviii. 54 (1879). *D. longipes* Mass. l.c., 236 (1892)?

Pl. 16.—*a.* sporangia; *b.* capillitium and spores; *c.* spore; (Philadelphia).

The types of *P. Petersii* var. *Farlowii* Rost., and *P. albicans* Peck are the same species as the specimen of *P. globuliferum* in the Strassburg collection. *P. columbinum* Macbride, from Iowa (B.M. 1012), is also *P. globuliferum*; it has snow-white, occasionally red-brown, stalks, and well-developed conical columellae. In the specimen from Dr. Rex (B.M. 1202) marked by him "*P. Petersii* var. *Farlowii*, conglobate form," the sporangia are in clusters of from 6 to 14 together, as in the compound forms of *P. polycephalum*. Prof. Macbride has seen the type of *P. relatum* Morg., and considers it to be a delicate form of the present species.

*Hab.* On dead wood.—Poland (Strassb. Herb.); Sweden (B.M. 2100); Switzerland (B.M. 2101); Bohemia (B.M. 2102); Bonin Islands (K. 333); Borneo (B.M. 1200a); New Zealand (B.M. 2104); Philadelphia (B.M. 1202); Ohio (B.M. 1199); Iowa (B.M. 1015); Japan (B.M. 2103).

7. ***P. pulchripes*** Peck in Bull. Buff. Soc. N. Hist., i. 64 (1873). Plasmodium? Total height 1 to 2 mm. Sporangia stalked, globose, yellow-orange, orange-red to dark brown, sometimes grey from the absence of lime, about 0.5 mm. diam.; sporangium-wall membranous, with deposits of lime usually abundant, sometimes scanty. Stalk vermilion-red or red-brown, 0.5 to 1.5 mm. long, 0.1 mm. thick, somewhat narrowed upwards, densely charged with red or brown lime-granules, brittle. Columella conical. Capillitium with red or reddish-brown lime-knots, in other respects as in *P. globuliferum*. Spores violet-brown, almost smooth, 6 to 8  $\mu$  diam.—Mass. Mon., 315. *P. Petersii* Berk. & Curt. in Grev., ii. 66 (1873); Mass. l.c., 295, in part. *P. Ravenelii* Mass. l.c., 281. *P. rufipes* Macbr. N. Am. Slime-Moulds, 50 (1899). *Didymium erythrinum* Berk. in Grev., ii. 52 (1873); Mass. l.c., 249. *D. Ravenelii* Berk. & Curt. in Grev., ii. 53. *Cytidium rufipes* Morg. Myx. Miami Valley, 81 (1896).

Pl. 17.—*a.* sporangia; *b.* capillitium and spores; *c.* spore; (Philadelphia.)

A frequent species in the United States, differing from *P. globuliferum* chiefly in the red colour of the lime; this character appears to be constant. Prof. Macbride has named the present species *P. rufipes*.

This specific name had its origin in *Physarum aurantium*  $\beta$  *rufipes* Alb. & Schw. (Consp. Fung., 94, 1805), = *Diderma rufipes* Fr. Syst. Myc., iii. 101 (1829), = *P. Schumacheri* var. *rufipes* Rost. Mon., App. p. 7. The single German gathering described under these names has long since disappeared; in the original description Albertini and Schweinitz make no mention of the presence or absence of lime in the stalk; the sporangia are said to be globose or obovate, to be provided with a spurious central columella, and to have been found "on a heap of dead leaves, twigs, etc."; these characters are not appropriate to *P. pulchripes*, a species which appears always on dead wood, and has been recorded hitherto with certainty only from the United States. What *P. aurantium*  $\beta$  *rufipes* Alb. & Sch. really was remains a matter for conjecture; Rostafinski states that he had not seen the type specimen. It would seem better therefore to drop the specific name *rufipes*. The type of *Didymium erythrinum* Berk. (K. 1265) is somewhat immature, but shows the opaque red-brown stalks densely charged with lime throughout characteristic of *P. pulchripes*; it was wrongly placed by Rostafinski under *P. psittacinum* (Mon., App. p. 8), a species without columella, and with translucent stalks free from lime granules. The type of *Didymium Ravenelii* Berk. & Curt. from North Carolina (B.M. 1738) is a form of the present species with red-brown stalks, columellae and lime-knots. The type of *P. Petersii* Berk. & Curt. from Alabama (K. 1254) is also identical with *P. pulchripes*. Peck's name is here adopted as being free from ambiguity.

8. ***P. murinum*** Lister Mycetozoa, 41 (1894). Plasmodium? Sporangia globose, about 0.5 mm. diam., stalked or sessile and forming plasmodiocarps, pale pinkish or greyish brown, rugose; sporangium-wall membranous, with included clusters of brown lime-granules. Stalk erect, 0.5 mm. long or shorter, 0.1 mm. thick, of equal breadth throughout, brown, furrowed, containing dense deposits of white or brown lime-granules. Columella present only in the stalked forms, conical. Capillitium forming either a dense network of widely branching hyaline threads, persistent after the dispersion of the spores, with ovoid brown lime-knots, or a looser network of hyaline threads, with numerous elongated irregularly branching lime-knots. Spores pale brownish-violet, nearly smooth, 8 to 10  $\mu$  diam.—*P. Braunianum* Lister in Journ. Bot., xxix. 259 (1891) (*non* Rost). *P. Ravenelii* Macbr., N. Am. Slime-Moulds, 48 (1898) (*non* Mass). *Cytidium Ravenelii* Morg. Myx. Miami Valley, 82 (1896).

Pl. 18.—a. sporangia; b. capillitium and spores; c. spore; (Philadelphia).

This species is closely allied on the one hand to *P. globuliferum* and on the other to *P. pulchripes*; it is distinguished from both by the brown colour of the sporangium, lime-knots and stalk.

*Hab.* On dead leaves and wood.—North Wales (B.M. 2106), Moffat, Scotland (B.M. slide); Sweden (B.M. 2107); Switzerland (Zürich Herb.); Philadelphia (B.M. 1204); Ohio (B.M. 1203).

9. ***P. pulcherrimum*** Berk. & Rav. in Grev., ii. 65 (1873). Plasmodium? Total height 1 mm. Sporangia stalked,

globose, flattened beneath, erect or inclined, purple, 0.4 to 0.5 mm. diam., gregarious; sporangium-wall membranous, pale purple, with scattered clusters of large purple globular lime-granules ( $1\ \mu$  diam.). Stalk purple, subulate, 0.5 to 1 mm. long, brittle, containing lime. Columella small, convex, or none. Capillitium a close network of delicate purplish threads, broader and more expanded at the axils below; lime-knots numerous, small, roundish, filled with purple globular lime-granules. Spores pale dull red, almost smooth, 7 to  $8\ \mu$  diam.—Rost. Mon., p. 105, fig. 84; Macbr. N. Am. Slime-Moulds, 49. *Physarum atrorubrum* Peck. in Rep. New York Mus., xxxi. 40 (1879); Mass. Mon., 294.

Pl. 19.—a. sporangia; b. capillitium and spores; c. spore; (Ceylon).

Hab. On dead wood.—Ceylon (B.M. 2108); Ohio (B.M. 1207); Iowa (B.M. 1013); South Carolina (B.M. 412); Philadelphia (B.M. 1809).

10. *P. citrinum* Schumacher Enum. Pl. Saell., ii. 201 (1803). Plasmodium bright yellow. Total height 0.8 to 2 mm. Sporangia globose, rugose, stalked, rarely nearly sessile, erect, yellow to yellowish-grey, 0.4 to 0.7 mm. diam.; sporangium-wall membranous with included clusters of yellow lime granules. Stalk golden-yellow, opaque with dense deposits of lime, stout, somewhat furrowed, 0.1 to 0.6 mm. long, chalky in section, often rising from a vein-like hypothallus. Columella short, conical or obtuse. Capillitium a somewhat close network of hyaline rigid threads with flat expansions at the axils, persistent after the dispersion of the spores; lime-knots yellow, numerous, varying in shape and size, usually rounded, seldom developed at the axils of the branches. Spores violet-brown, almost smooth, 7 to  $10\ \mu$  diam.—Fr. Symb. Gast., 22 (1818); Macbr. N. Am. Slime-Moulds, 56. *P. compactum* Ehrenb. Syl. Ber., 21 (1818). *P. Schumacheri* Spreng. Sys. Veg., iv. 528 (1827); Rost. Mon., p. 98; Mass. Mon., 275. *P. aureum*  $\beta$  *chrysopus* Lev. in Ann. Sc. Nat., sèr. 3, v. 166 (1846). *P. Schroeteri* Rost. l.c., 419? *P. Leveillei* Rost. Mon., App. p. 7 (1876), in part; Mass. l.c., 296.

Pl. 20.—a. sporangia; b. capillitium and spores; c. spore; (Bedfordshire).

Rostafinski describes *P. Leveillei* as being closely allied to the present species, but having larger spores, measuring 10 to  $11\ \mu$  instead of 7 to  $8\ \mu$ . His type of *P. Leveillei*  $\alpha$  from Freiburg, leg. de Bary (Strassb. Herb.), is *P. citrinum* with large yellow sporangia and spores  $8\ \mu$  diam.; the gathering from Venezuela (K. 1261) quoted by him as *P. Leveillei*  $\beta$  *auripes* is *P. citrinum* with rather long stalks, and spores measuring  $10\ \mu$ ; his *P. Leveillei*  $\alpha$  from Chili (ex herb. Gay, Paris Herb.) is typical *P. viride*.

Hab. On dead wood and moss.—Hertfordshire (B.M. 1208); Falmouth (B.M. 2110); Aberdeen (B.M. 2109); Switzerland (B.M. 2111); Austria (B.M. 2112); Germany (B.M. 1209); Venezuela (K. 1261).

11. **P. tenerum** Rex in Proc. Acad. Nat. Sci. Phil., 1890, 192. Plasmodium primrose-yellow. Total height 1 to 2 mm. Sporangia globose, stalked, erect or nodding, gregarious, yellow, seldom grey, 0.4 mm. diam.; sporangium-wall membranous with closely-set rounded clusters of included granules. Stalk subulate, slender, opaque, 0.5 to 1.7 mm. long, pale yellow, and filled with lime above, darker below from the presence of refuse matter. Columella none. Capillitium of very slender hyaline threads forming a regularly meshed network, often persistent after the dispersion of the spores, with numerous round or rounded yellow lime-knots, the axils of the branches slender and mostly free from lime. Spores brownish-violet, nearly smooth, 7 to 8  $\mu$  diam. *P. maculatum* Macbr. in Bull. Lab. Nat. Hist. Iowa, ii. 383 (1893); Macbr. N. Am. Slime-Moulds, 47. *P. obrusseum* Macbr. l.c., 52, in part (1899). *Lepidoderma Kurzii* Berk. in Herb.; Mass. Mon., 255 (1892) ?

Pl. 25.—*a.* sporangia; *b.* capillitium and spores; *c.* spore; (Philadelphia).

This species is closely allied to *P. citrinum*, differing in the more slender form, in the delicate flexuose capillitium threads connecting the lime-knots, and in the absence of a columella.

*Hab.* On dead wood.—Portugal (B.M. 2114); Antigua (B.M. 1646); Adirondack Mountains, New York (B.M. 1891); Ohio (B.M. 1213); Brazil (B.M. 2115); Japan (B.M. 2116); Borneo (B.M. 1212).

12. **P. compactum** Lister. Plasmodium ? Total height 1 to 2 mm. Sporangia stalked, globose or somewhat flattened below, 0.5 mm. diam., erect or nodding, spotted with pure white, grey or bronze colour and iridescent between the rounded spots; sporangium-wall membranous, with numerous well-defined rounded clusters of closely compacted lime granules. Stalk erect or flexuose, subulate, furrowed, 0.5 to 1.5 mm. long, 0.05 to 0.13 mm. thick at the base; white and densely charged with lime above, brown or black below from the presence of refuse matter; or white with chalky section to the base. Columella none, or represented by closely compacted lime-knots forming a globular cluster 0.1 mm. diam. near the apex of the stalk, but lying free in the capillitium. Capillitium abundant, of extremely delicate branching and anastomosing threads without expansions at the axils, somewhat persistent, and of a pale bluish colour after the dispersion of the spores; lime-knots white, few, small, fusiform, except in the central globular cluster. Spores violet-brown, almost smooth, 7 to 9  $\mu$  diam.—*Tilmadoche compacta* Wing. in Proc. Acad. Nat. Sci. Phil., 1889, 48; Mass. Mon., 332; Macbr. N. Am. Slime-Moulds, 61. *Lepidoderma stellatum* Mass. l.c., 252 (1892). *Didymium Barteri* Mass. l.c., 231.

Pl. 26.—*a.* sporangia; *b.* apex of stalk and capillitium, with fragment of sporangium-wall, showing sharply defined clusters of lime-granules; *c.* capillitium and spores; *d.* spore; (Dominica).

An excellent account of this species is given by Mr. Wingate (l.c.). He describes the sporangium-wall as splitting on maturity in a floriform manner, which is a marked character in many specimens; his description of the stalk as "yellowish-white with a brown or blackish base" appears to be correct for the American gatherings. In a fine specimen of *P. compactum* in the Kew collection from Dominica, K. 567 (type of *Lepidoderma stellatum* Mass.) the stalks are pure white with a chalky section to the base. A specimen from French Guiana in the Paris Museum, under the name *Physarum leucophaeum*, is precisely similar in all respects to the Dominica gathering of *P. compactum*. The type of *Didymium columbinum* Berk. & Curt. (*Tilmadoche columbina* Rost. Mon., App. p. 13), Venezuela (K. 1428), may be this species, but nothing now remains of the specimen but a few stalks and a little of the extremely delicate capillitium. *D. Barteri* Mass. (type in Herb. Massee) collected by Barter on Prince's Island, Niger Expedition, in 1881, is clearly *P. compactum*; the specimen is quoted under *P. globuliferum* by Rostafinski (Mon., App. p. 5).

*Hab.* On dead wood.—Java (B.M. 2117); Borneo (B.M. slide); Dominica (K. 567); Philadelphia (B.M. 875); Ohio (B.M. 1214); Kansas (B.M. 2118); South Carolina (B.M. 571); Antigua (B.M. 1647); Brazil (B.M. 2119).

13. **P. mutabile** Lister. Plasmodium? Sporangia cylindrical, ovoid, or subglobose, 0.2 to 0.6 mm. diam., white, rugulose, either stalked or sessile, often forming elongated branched plasmodiocarps; sporangium-wall with rather evenly distributed deposits of white lime-granules. Stalks stout or slender, 0.1 to 0.4 mm. high, ochraceous-yellow, usually enclosing white lime granules but sometimes almost free from lime, often connected at the base by a yellowish or white hypothallus. Capillitium a persistent network of firm hyaline threads with expansions at the axils; lime-knots white, varying in size and shape, either scattered through the capillitium, or in the stalked forms for the most part confluent in the centre of the sporangium and forming a clavate columella which is either free or continuous with the apex of the stalk. Spores purple-brown, spinulose, 7 to 8  $\mu$  diam.—*Crateriachea mutabilis* Rost. Mon., p. 126 (1875); Mass. Mon., 344. *Physarum cinereum* Lister Mycetozoa, 56 (1894), in part. *P. Crateriachea* Lister in Journ. Bot., xxxiii. 323 (1895).

Pl. 44.—*a.* sporangia (from near Luton, Beds); *b.* capillitium and spores; *c.* spore.

A widely distributed and variable species. In this country it is sometimes found in great abundance on heaps of old straw, dead leaves or herbaceous stems; stalked, sessile or plasmodiocarp forms occur side by side, while the lime-knots show every stage from being quite free to uniting to form a well-defined clavate or cylindrical columella. The specimens distributed by Cesati as "*Didymium neapolitanum*," from Naples (B.M. 573), and also those marked *Didymium squamulosum* var. *herbarum* by Rabenhorst & Winter, no. 2969, from Pavia (B.M. 542),

are the sessile subglobose form of the present species; in both the lime-knots are partly free, partly united to form an irregular pseudo-columella.

*Hab.* On dead leaves, herbaceous stems, etc.—Beds (B.M. 2158); Wilts (B.M. 1548); Surrey (B.M. 2160); near Paris (B.M. 2159); Sweden (Herb. Dr. R. E. Fries); Germany (Herb. Strassburg); Italy (B.M. 573); Cameroons, West Africa (B.M. 2161); Ceylon (B.M. 2162).

14. *P. roseum* Berk. & Br. in Journ. Linn. Soc., xiv. 84 (1873). Plasmodium maroon-red. Total height 1 mm. Sporangia globose, 0.4 mm. diam., stalked, gregarious, nearly smooth, bright rose-coloured; sporangium-wall membranous, with included clusters of purple-red lime-granules. Stalk erect, slender, subulate, bright brown, translucent, longitudinally rugose. Columella none. Capillitium a loose network of delicate pale lilac threads, with rather few large irregularly branching purple-red lime-knots. Spores reddish-lilac or reddish-brown, minutely spinulose, 7 to 10  $\mu$  diam.—Rost. Mon., App. p. 10; Mass. Mon., 294; Petch in Ann. Perad., iv. 331.

Pl. 27.—*a.* sporangia (Ceylon); *b.* capillitium and spores; *c.* spore.

This species differs from *P. pulcherrimum* in the large lime-knots and the translucent bright brown stalks.

*Hab.* On dead wood.—Ceylon (B.M. 2121); Borneo (B.M. 2122); Java (B.M. 2120); Japan (1993).

15. *P. Newtoni* Macbride in Bull. Nat. Hist. Iowa, ii. 390 (1893). Plasmodium? Sporangia shortly stalked or sessile, globose, or flattened and umbilicate above, about 0.5 mm. diam., violet-purple, smooth, opaque; sporangium-wall membranous above, with included deposits of purple lime-granules, rugose and thickened towards the base where it is deep purple and densely charged with calcareous deposits. Stalk strongly wrinkled, purple-brown. Columella none. Capillitium consisting of delicate branching violet threads, with numerous large angular purple lime-knots. Spores dark purple-brown, rough with irregularly scattered warts, 8-10  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 37.

Pl. 28.—*a.* stalked and sessile sporangia; *b.* capillitium and spores; *c.* spore; (Colorado).

The shape of the sporangia and the dark rough spores appear to be the only points which distinguish this rare species from *Craterium paraguayense* (Spegaz.) Lister, with which it agrees in colour, in the character of the capillitium, and in the structure of the sporangium-wall.

*Hab.* On sticks at an altitude of several thousand feet, Pikes Peak, Colorado (B.M. 1014).



16. *P. psittacinum* Ditm. in Sturm Deutsch. Fl., Pilze, 125, t. 62 (1817). Plasmodium orange. Total height 1 mm. Sporangia stalked, globose or somewhat depressed, gregarious, 0.5 to 0.8 mm. diam., purplish-blue mottled with red, iridescent; sporangium-wall hyaline, delicately membranous, sprinkled with orange spots of thicker more or less granular substance. Stalk erect or curved, furrowed, vermilion or orange-red, intense clear orange in mountings in glycerine, without deposits of lime, rising from a well-developed hypothallus of the same colour. Columella none. Capillitium a close network of flat arching colourless or yellowish threads, broad at the axils; lime-knots numerous, varying in size, sharply angular, often branching, or confluent in the centre of the sporangium, bright orange, obscurely granular or translucent. Spores greyish-violet, nearly smooth, 7 to 8  $\mu$  diam.—Rost. Mon., p. 104, figs. 75, 76; Mass. Mon., 274; Macbr. N. Am. Slime-Moulds, 51. *P. Carlylei* Mass. l.c., 293.

Var. *fulvum* Lister: stalk and base of sporangium-wall fulvous-yellow instead of vermilion.—Lister in Journ. Bot. xliv. 228 (1906).

Pl. 29.—*a.* sporangia (Lyme Regis); *b.* sporangia of var. *fulvum* (Ceylon); *c.* capillitium and spores, with fragment of sporangium-wall showing crystalline discs; *d.* spore.

In glycerine mountings of this species flattened disc-shaped crystalline bodies with radiating structure are usually seen imbedded in the sporangium-wall, as in *P. virescens* and *P. dictyospermum*. The type specimen of *P. Carlylei* Mass. from Carlisle (K. 68) is normal *P. psittacinum*.

*Hab.* On dead wood.—Lyme Regis, Dorset (B.M. 1217); Cornwall (B.M. 2123); Wales (B.M. 2125); Dublin (2124); Berlin (B.M. 2126); Sweden (B.M. 2127); Austria (B.M. 2128); Switzerland (Herb. Zürich); Massachusetts (B.M. 2129); New York (B.M. 1894): var. *fulvum*—Ceylon (B.M. 2130); Japan (B.M. 1994).

17. *P. dictyospermum* Lister in Journ. Bot., xliii. 112 (1905). Plasmodium? Sporangia subglobose, shortly stalked, erect, scattered, 0.5 to 0.6 mm. diam., dull orange or dark olive-brown, glossy; sporangium-wall membranous, rather firm, orange. Stalk 0.1 to 0.5 mm. high, black, enclosing dark refuse matter, or sometimes pale yellow above from superficial deposits of lime-granules. Columella black, conical or hemispherical, short or one-third the height of the sporangium. Capillitium an abundant persistent network of slender colourless threads, with small fusiform orange-red lime-knots. Spores pale purplish-grey, 10 to 11  $\mu$  diam., closely reticulated with narrow dark bands; these form a net with five or six meshes in a row on one side of the spore; on the other side the meshes are more faint and irregular.—Torrend Fl. Myx., 195.

Pl. 30.—*a.* sporangia; *b.* capillitium and spores, with fragment of sporangium-wall showing the crystalline discs; *c.* two spores showing respectively the strong and delicate reticulation of the two sides.

The only record of this species is a gathering of twenty-seven sporangia, made by Miss A. Hibbert-Ware in dense bush on Stewart Island, New Zealand. It is distinguished from the other known species of *Physarum* by the strongly reticulated spores. Its nearest ally is, perhaps, *P. psittacinum*, which it resembles in having orange-red lime-knots, and in the sporangium-wall being studded with orange crystalline discs.

*Hab.* On dead wood.—New Zealand (B.M. 2131).

18. *P. viride* Pers. in Usteri Ann. Bot., xv. 6 (1795). Plasmodium yellow. Total height about 1 mm. Sporangia stalked, subglobose, lenticular, nodding, 0.3 to 0.5 mm. diam., yellow; sporangium-wall dehiscing in fragments, membranous, with included clusters of yellow lime-granules more or less closely disposed. Stalk subulate, slender, striate, grey or straw-coloured, sometimes yellow at the apex shading to red below, usually brown in the lower half from enclosed refuse matter, without deposits of lime. Columella none. Capillitium a loose irregular network of slender acutely branching hyaline threads, with fusiform orange lime-knots. Spores brownish-violet, almost smooth, 7 to 10  $\mu$  diam. — Ditm. in Sturm Deutsch. Fl., Pilze, 49, t. 24. *Sphaerocarpus viridis* Bull. Champ., t. 407, fig. 1 (1791). *Stemonitis viridis* Gmel. Syst. Nat., ii. 1469 (1791). *Physarum aureum* Pers. in Roemer N. Mag. Bot., 88 (1794). *P. nutans*  $\beta$  *viride*,  $\gamma$  *aureum* Fries Syst. Myc., iii. 129 (1829). *Trichia viridis* DC. Fl. Fr., ii. 253 (1805). *Tilmadoche mutabilis* Rost. Mon., p. 129 (1875); Mass. Mon., 329. *T. viridis* Sacc. in Michelia, ii. 263 (1880); Macbr. N. Am. Slime-Moulds, 59.

Var. 1.—*aurantium* Lister: sporangia orange, lime-knots orange, fusiform. *Sphaerocarpus aurantius* Bull. l.c., t. 484, fig. 2. *Stemonitis aurantia* Gmel. l.c., 1469. *Physarum aurantium* Pers. Syn. Fung. 173. *P. nutans*  $\gamma$  *coccineum* Fr. l.c. *P. striatum* c *aurantiacum* Fr. l.c., 131. *Trichia aurantia* DC. l.c.,

Var. 2.—*incanum* Lister: sporangia grey or pale-yellowish grey, lime-knots pale yellow, fusiform. *Sphaerocarpus luteus* Bull. l.c., t. 407, fig. 2? *Stemonitis bicolor* Gmel. l.c., 1469. *Physarum luteum* Pers. Syn. Fung., 172 (1801). *Trichia lutea* DC. l.c.

Var. 3.—*rigidum* Lister: sporangia yellow or dull orange; lime-knots long, simple and rod-like, or forked, orange; hyaline threads often scanty; spores 9 to 12  $\mu$ .—Minakata in Bot. Mag. Tokyo, xxii. 318 (1908).

Pl. 31.—*a.* sporangia (England); *b.* sporangia of var. *aurantium* (England); *c.* sporangia of var. *incanum* (England); *d.* capillitium and spores; *e.* spore.

Pl. 199.—var. *rigidum*; *a.* sporangia (Japan); *b.* spores and capillitium, with fragment of sporangium-wall; *c.* spore.

In this abundant and variable species, the sporangium-wall as in *P. nutans* is somewhat persistent when the lime is abundant; when this is more scanty the wall soon breaks up in small fragments, remaining attached to the capillitium. The colour of the sporangia found on the same stump may differ from one year to another. The lime-knots are very variable both in size and colour; pale yellow sporangia have often red-brown knots, and dark sporangia have light orange knots. The stalks vary in tint in all forms. The specimen from Chili (*leg. Gay*) in the Paris Museum, given by Rostafinski (*Mon., App. p. 7*) as a type of *Physarum Leveillei* var. *chrysopus*, is the orange form of *P. viride*; the stalks are free from lime deposits and the capillitium consists of slender threads with fusiform orange lime-knots. The var. *rigidum* has marked characteristics, but is connected with typical *P. viride* by intermediate forms. The lenticular sporangia are either convex, flat, or umbilicate above, and are often somewhat iridescent from having little lime in their fragile walls; the stalks vary in colour as in other forms of *P. viride*; the capillitium consists in some gatherings of rather few simple or forked threads and flattened tubes, with scanty lime deposits, while in other gatherings it is composed of straight rod-like tubes densely charged with lime-granules, and attached to the sporangium-walls above and below either directly or by short hyaline threads; the spores are usually larger and rather darker than in typical *P. viride*. This variety has now been obtained from the West Indies, from Ceylon, and several times from Japan.

*Hab.* On dead wood.—Leytonstone, Essex (B.M. 1219); Bath-easton, Gloucestershire (B.M. 90); Yorks (B.M. 1046); France (Paris Herb.); Germany (B.M. 506); Norway (B.M. 1220); Portugal (B.M. 2132); Ceylon (K. 1420); Borneo (B.M. 1221); Japan (B.M. 1989); Bonin Islands (K. 335); Iowa (B.M. 805); New Jersey (B.M. 1223); Chili (Paris Herb.).

19. **P. Bethelii** Macbr. in litt. Plasmodium? Sporangia stalked, subglobose, umbilicate beneath, erect or inclined, 0.5 to 0.7 mm. diam., pale sulphur-yellow, or when free from lime iridescent-violet; sporangium-wall membranous with more or less abundant deposits of sulphur-yellow lime-granules. Stalk firm, dark brown or black, containing dark refuse matter, 0.1 to 0.5 mm. high. Columella none. Capillitium a dense network of delicate hyaline threads with irregular and often branching pale yellow lime-knots. Spores violet-brown, minutely warted, 9 to 10  $\mu$  diam.

Pl. 200.—*a.* iridescent sporangia (Colorado, from type specimen); *b.* capillitium and spores; *c.* spore; *d.* sporangia with abundant lime (Cheyenne Mountain, Colorado).

This species appears to be closely allied to *P. viride* var. *incanum*, from which it is distinguished by the stouter habit, the branching and larger lime-knots, and by the darker spores. It has been found twice, each time in Colorado, once by Mr. E. Bethel, once by Dr. Sturgis. The sporangia gathered by Dr. Sturgis vary from sulphur-yellow to iridescent-violet according to the lime in the walls being abundant or absent; those gathered by Mr. Bethel are iridescent-violet, but some show scanty pale yellow lime-deposits on the walls; the capillitium and spores are similar in both specimens.

*Hab.* On dead wood.—Colorado (B.M. 2133, 2134).

20. *P. polycephalum* Schwein. Syn. Fung. Carol., 63 (1822). Plasmodium occurring in masses of decaying leaves or in rotten logs; at first colourless, as it emerges for fructification white, then yellow, spreading far over all adjacent objects (Macbride). Total height 1.5 to 2 mm. Sporangia stalked, compressed vertically, lenticular, undulate or lobed, confluent in clusters of 5 to 10 together, grey or yellow; sporangium-wall membranous, with scattered thin included clusters of white or yellow lime-granules. Stalks subulate, slender, inclined, usually fasciculate, 5 to 10 combined, yellow or tawny, translucent, without deposits of lime. Columella none. Capillitium a loose network of slender threads with many flat expansions at the axils; lime-knots yellow, very variable in shape, size, and abundance. Spores violet-brown, minutely spinulose, 8 to 10  $\mu$  diam.—*Didymium polycephalum* Fries Syst. Myc., iii. 122 (1829). *D. polymorphum* Mont. in Ann. Sci. Nat., ser. 2, viii. 361 (1837). *D. gyrocephalum* Mont. l.c., 362. *D. luteogriseum* Berk. & Curt. in Grev., ii. 65 (1873). *Physarum polymorphum* Rost. Mon., p. 107 (1875); Mass. Mon., 283; Lister Mycetozoa, 48. *Tilmadoche gyrocephala* Rost. l.c., p. 131 (1875); Mass. Mon., 335. *T. polycephala* Macbr. N. Am. Slime-Moulds, 57 (1899).

Var. *obrusseum* Lister: sporangia single, not united in clusters.—*Didymium obrusseum* Berk. & Curt. in Journ. Linn. Soc., x. 348 (1869). *D. tenerrimum* Berk. & Curt. l.c.; Mass. Mon., 247. *Physarum obrusseum* Rost. Mon., App. p. 11 (1876); Macbr. N. Am. Slime-Moulds, 52.

Pl. 34.—*a.* yellow and grey sporangia (Philadelphia); *b.* capillitium and spores; *c.* spore.

The description given by Schweinitz of *Physarum polycephalum* is sufficiently good to leave no doubt as its referring to the present species; this name therefore takes precedence over *Physarum polymorphum* (Mont.) Rost. The four specimens referred to in Rostafinski's Monograph under the latter name, from Cuba, S. Carolina, New Jersey, and Pennsylvania, are in the Kew Herbarium. The type of *Tilmadoche gyrocephala* (Mont.) Rost. from Brazil appears to have been lost, but from Rostafinski's excellent description it clearly must be assigned to the present species. The type of *Didymium obrusseum* Berk. & Curt., no. 532 Fung. Cub. (B.M. 440) has much compressed and undulated sporangia, similar to the simple sporangia frequently met with in *P. polycephalum*. The colour of the sporangia varies from grey to yellow in the same gatherings.

*Hab.* On dead wood, etc.—Pennsylvania (B.M. 860); Iowa (B.M. 1227); Ohio (B.M. 1225); Brazil (B.M. 2135); Borneo (B.M. 2138); Japan (B.M. 2137); var. *obrusseum*—Cuba (B.M. 440).

21. *P. flavicomum* Berk. in Hook. Lond. Journ. Bot., iv. 66 (1845). Plasmodium yellowish-green (*teste* Ravenel). Total height 1.2 to 1.75 mm. Sporangia subglobose, or

flattened beneath, stalked, nodding, 0.4 to 0.5 mm. diam., yellow, or grey with a yellow base, or iridescent from the absence of lime, smooth; sporangium-wall membranous, colourless above, yellowish below. Stalk slender, subulate, striate, without deposits of lime, red or copper-coloured. Columella none. Capillitium a close network of slender hyaline threads with numerous yellow flat expansions at the axils; often persistent and retaining the form of the sporangium after the dispersion of the spores; lime-knots usually small, angular, yellow. Spores pale violet-brown, almost smooth, 7 to 9  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 53. *P. cupripes* Berk. & Rav. in Grev., ii. 65 (1873); Mass. Mon., 284. *P. Berkeleyi* Rost. Mon., p. 105 (1875); Lister Mycetozoa, 47. *Didymium flavicomum* Mass. l.c., 242 (1892).

Pl. 32.—*a.* sporangia (South Carolina); *b.* capillitium and spores.

The red-brown stalks usually free from all refuse matter, the denser net of the capillitium and more angular lime-knots distinguish this species from *P. viride*. It appears to be closely allied to both *P. galbeum* Wing., and *P. Maydis* (Morg.) Torrend; from the former it differs in having red-brown, not yellow stalks, and in the well-defined lime-knots; from the latter in the more slender habit, and in the persistent dense network of the capillitium.

*Hab.* On dead wood.—South Carolina (B.M. 439, 870, 993); New Jersey (B.M. 1794); New Zealand (B.M. 2139).

22. *P. galbeum* Wing. in Macbr. N. Am. Slime-Moulds, 53 (1899). Plasmodium? Sporangia globose, scattered, stalked, usually erect, 0.4 to 0.5 mm. diam., bright yellow, smooth; sporangium-wall membranous, with rather dense clusters of yellow lime-granules. Stalk subulate or nearly cylindrical, 0.5 to 0.7 mm. high, translucent, yellow, or yellow above and orange-red below. Columella none. Capillitium a dense network of pale yellow threads or flattened strands; lime-knots reduced to scanty deposits of lime in the expanded axils of the branches. Spores pale violet, almost smooth, 7 to 9  $\mu$  diam.

Pl. 199.—*d.* sporangia (Philadelphia); *e.* capillitium and spores; *f.* spore.

This species is closely allied to *P. flavicomum* (q.v.), but the distinguishing characters appear to be constant; it has been found in several States of N. America, in England, and in Portugal.

*Hab.* On dead twigs.—Witley, Surrey (B.M. 2140); Shropshire (B.M. 2141); Portugal (B.M. 2142); Philadelphia (B.M. 1893).

23. *P. Maydis* Torrend Flore des Myxomycètes, 193 (1909). Plasmodium? Sporangia globose or obovoid, 0.4 to 0.6 mm. diam., stalked, scattered or gregarious, bright yellow or dull yellowish-buff, rugulose or scaly, often rufous below; sporangium-wall yellow and membranous above, usually firm and redder at the base, containing abundant deposits of yellow

lime-granules. Stalk firm, dark red-brown, translucent, 0.1 to 0.6 mm. high, stout or slender. Columella none. Capillitium a network of hyaline threads with expansions at the axils; lime-knots numerous, branching, yellow, some occasionally uniting to form a pseudo-columella. Spores pale violet, nearly smooth, 9 to 10  $\mu$  diam. *Craterium Maydis* Morg. Myx. Miami Valley, 87 (1896); Macbride N. Am. Slime-Moulds, 74.

Pl. 32.—*c.* sporangia (Ceylon); *d.* capillitium and spores; *e.* spore.

The slender forms of this species closely resemble *P. flavicomum*, while the stouter forms with short stalks appear to merge insensibly into *P. auriscalpium*; it presents, however, a distinct and fairly constant centre, and has now been obtained from Ohio and Iowa in the United States, and from Antigua, Ceylon, and Java. It has been placed by Mr. Morgan and Professor Macbride in the closely allied genus *Craterium* on account of the thickened base of the sporangium-wall; but this feature is not always present, and is one that may also be seen to a certain extent in both *P. flavicomum* and *P. auriscalpium*. We therefore follow Dr. Torrend in transferring *Craterium Maydis* to the genus *Physarum*, that it may stand between the two species with which it appears to form the connecting link.

*Hab.* On dead wood, twigs, maize stalks, etc.—Iowa (B.M. 1017); Antigua (B.M. 1649); Ceylon (B.M. 2143); Java (B.M. 2144).

24. *P. auriscalpium* Cooke in Ann. Lyc. Nat. Hist. New York, xi. 384 (1877). Plasmodium? Sporangia subglobose, 0.4 to 0.8 mm. diam., stalked or sessile, yellow, orange or rufous, rugulose or scaly, scattered or in small clusters; sporangium-wall membranous, with clustered deposits of lime-granules. Stalk red-brown or blackish-brown, translucent, 0.1 to 0.4 mm. high. Capillitium consisting of large branching orange-yellow lime-knots, connected by short hyaline threads. Spores brownish-violet, minutely spinulose, 9 to 10  $\mu$  diam.—Lister in Journ. Bot., xxxvi. 115; Macbr. N. Am. Slime-Moulds, 38. *P. ornatum* Peck in Rep. N. Y. Mus., xxxi. 40 (1879). *P. oblatum* Macbr. Bull. Lab. Nat. Hist. Iowa, ii. 384 (1893). *P. sulphureum* Sturgis in Bot. Gaz., xviii. 197, t. xx, figs. 5–8 (1893). *Badhamia citrinella* Cel. fil. Myx. Böhm., 76, t. iv, fig. 1 (1893)\*; see Lister in Journ. Bot., xl. 211.

Pl. 33.—*a.* sporangia (South Carolina); *b.* capillitium and spores; *c.* spore.

This species is closely allied on the one hand to *P. Maydis* and on the other to *Badhamia decipiens* (q.v.; see also note to *P. pusillum*, p. 65.)

*Hab.* On dead wood and twigs.—Near Paris (B.M. 2148); North Germany (B.M. 2145); Portugal (B.M. 2146); New Hampshire (B.M. 1717); South Carolina (B.M. 863).

25. *P. fulvum* Lister *non* Fries. Plasmodium yellow. Sporangia globose or obovoid, 0.6 to 0.8 mm. diam., cream-white or pale fulvous, nearly smooth or rugulose, stalked or sessile,

\* In Arch. Naturw. Land. Böhm. vii. 5, p. 76.

with a hypothallus of branching fulvous strands; sporangium-wall of two closely connected layers enclosing abundant deposits of lime-granules. Stalk 0.1 to 0.5 mm. long, fulvous, weak and almost membranous, expanding below into strands of the hypothallus. Columella none. Capillitium a dense persistent network of nearly colourless threads, with membranous expansions at the axils, and with scattered angular often branched pale yellow lime-knots. Spores dark purple-brown, spinulose, 10 to 12  $\mu$  diam. *Leocarpus fulvus* Macbr. N. Am. Slime-Moulds, 82 (1899).

Pl. 66.—*a.* sporangia; *b.* capillitium and spores, with fragment of sporangium-wall; *c.* spore; (Colorado).

The type of this species was gathered by Mr. E. Bethel "on living willow," growing in snow, 11,000 feet altitude, Loveland Pass, Colorado, in June, 1896. Dr. Sturgis has kindly allowed us to examine two other specimens, both of which were sent him by Mr. Wingate under the name "*Physarum albescens* Phillips," and which he agrees with us in thinking should be placed under *P. fulvum*. He has not been able to trace the origin of the name "*P. albescens*" Phillips, and apparently it has never been published. One specimen is marked "Iowa, *leg.* Holway, *ex herb.* Rex," the other "Louisiana, *leg.* Langlois, *ex herb.* Ellis." In both gatherings the pale cream-coloured sporangia are either subglobose and sessile, or form short plasmodiocarps, and show but little development of hypothallus; they agree in other respects with the type of *P. fulvum*, except that the lime-knots in the Louisiana specimens are smaller and brighter yellow, and the Iowa specimen has rather paler and smoother spores that measure only 8 to 10  $\mu$ .

*Hab.* On leaves and twigs.—Near Denver, Colorado (B.M. 2147)

26. ***P. penetrale*** Rex in Proc. Acad. Nat. Sci. Phil., 1891, 389. Plasmodium? Sporangia stalked, erect, ellipsoid, or globose, 0.3  $\times$  0.5 mm. diam., grey or pale greenish-yellow, smooth; sporangium-wall membranous, rather firm, semi-transparent, with innate scattered clusters of pale yellow or white lime-granules, rupturing when mature into from two to four segments. Stalk erect or curved, 0.5 to 2 mm. high, slender, subulate, smooth and solid, translucent, dull red or golden-red. Columella formed by a continuation of the stalk, penetrating the sporangium to about four-fifths its height, slender, scarcely tapering to the abruptly conical or expanded end, yellow. Capillitium a close network of hyaline threads with triangular expansions at the axils of the branches, arising from the whole length of the columella, persistent after the dispersion of the spores; lime-knots scattered, small, rounded, yellow. Spores pale brownish-violet, delicately spinulose, 5 to 6.5  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 55.

Pl. 36.—*a.* sporangia (Ireland); *b.* sporangium after dispersion of spores showing the long columella, from a glycerine preparation; *c.* capillitium and spores; *d.* spores.

An immature specimen of this remarkable species occurs in the Strassburg collection named by Rostafinski "*Craterium leucocephalum*,

*unreif.*" It has now been obtained from east and west North America, from England, Scotland, and Ireland, from Sweden, Germany, and Portugal, and from Java.

*Hab.* On dead wood and moss.—Luton, Beds (B.M. 2149); Ireland (B.M. 2150); Upsala (B.M. 2151); Lisbon (B.M. 2152); Philadelphia (B.M. 1229).

27. *P. citrinellum* Peck in Rep. N. Y. Mus. Nat. Hist., xxxi. 55 (1879). Plasmodium? Sporangia subglobose, 0·6 to 0·8 mm. diam., stalked, erect, gregarious, rugose, lemon-yellow or ochraceous, tinged with orange at the base; sporangium-wall of two layers, the outer cartilaginous, yellow, rugose, with dense included deposits of lime, easily separating from the colourless membranous inner layer. Columella none. Stalk cylindrical, 0·3 to 0·4 mm. high, stout, plicate, orange-red, translucent. Capillitium a network of colourless hyaline threads, with many large, irregular, and branching white lime-knots. Spores purple-brown, rather strongly spinulose, 10 to 12  $\mu$  diam.—Mass. Mon., 278; Sturgis in Trans. Conn. Acad., x. 470-472. *P. caespitosum* Schwein. in Trans. Amer. Phil. Soc., n.s. iv. 258 (1832)?; Macbr. N. Am. Slime-Moulds, 37. *Didymium flavidum* Peck l.c., xxviii. 54 (1879). *Diderma citrinum* Peck non Fries l.c., xxii. 89 (1869). *Craterium citrinellum* Lister Mycetozoa, 74 (1894).

Pl. 68. *a.* sporangia (Japan); *b.* sessile sporangia (New Hampshire); *c.* capillitium and spores, with fragment of sporangium-wall; *d.* spore.

In the first edition of the present work this species was placed in the genus *Craterium* in view of its affinity with *C. aureum*; as however there is no tendency in *P. citrinellum* to form on dehiscing a regular cup, it seems better to replace it in the genus *Physarum*. The slight tendency in *C. aureum* to form such a cup allows us to regard it as a *Craterium*, though at this point the distinction between the two genera becomes obviously artificial. Other differences from *C. aureum* are the more globose stouter-walled sporangia, and the larger rougher spores. Professor Macbride has regarded *P. caespitosum* Schwein. as being probably the present species, but Schweinitz's type appears to have been lost; the original description is short and no mention is made of the colour or structure of the stalk; this reference therefore is very uncertain. Dr. Sturgis has examined the type of *P. flavidum*, which was first described by Peck under *Didymium* in 1875, and finds that it is an immature specimen of the present species with sessile or shortly stalked sporangia (see Sturgis, l.c.); this name was not actually published, however, till 1879, the year in which a more definitely stalked form of the same species was published by Peck as *P. citrinellum*, under which name it has generally been distributed in the United States. In the first edition of "Mycetozoa," p. 62, the opinion was expressed that *P. flavum* Fr. was probably the present species; but the description given by Fries of the yellowish-white stalks of his *P. flavum* applies rather to *P. sulphureum* Alb. & Schw. (q.v. 46) than to *P. citrinellum*, the stalks of which are orange-red and translucent. *P. citrinellum* has hitherto been recorded only from the United States and Japan.

*Hab.* On dead wood and moss.—Adirondack Mts., N.Y. (B.M. 1283, 1892); Japan (B.M. 2153).



28. *P. carneum* G. Lister & Sturgis in Journ. Bot., xlviii. 73 (1910). Plasmodium? Sporangia gregarious, stalked, subglobose, 0.4 to 0.6 mm. diam., ochraceous-yellow, with a pinkish flesh-coloured base, smooth or rugulose; sporangium-wall membranous, pale yellow, with evenly distributed deposits of lime-granules, thicker at the base. Stalk cylindrical, pinkish flesh-coloured, translucent, without deposits of lime, 0.2 to 0.3 mm. high. Capillitium a dense network of fragile angular and branching white lime-knots with short connecting hyaline threads. Spores purplish-brown, spinulose, 8  $\mu$  diam.

This species was found in some abundance on dead wood, on Cheyenne Mt., Colorado Springs, by Dr. W. C. Sturgis, in the autumn of 1908. It appears to be allied to *P. citrinellum* Peck, but differs in the membranous sporangium-wall, in the closer network of the capillitium, in the slender flesh-coloured stalks, and smaller spores.

*Hab.* On dead wood.—Colorado (B.M. 3188).

29. *P. brunneolum* Mass. Mon., 280 (1892). Plasmodium? Sporangia globose, or subglobose and slightly depressed, stalked or sessile, 0.6 to 0.9 mm. diam., gregarious, yellow-brown, glossy; sporangium-wall dehiscing in revolute lobes, consisting of two layers, the outer yellow-brown, cartilaginous, the inner membranous, enclosing abundant deposits of white lime-granules. Stalk firm, cylindrical, red-brown or nearly black, without lime, 0.2 to 0.4 mm. high. Capillitium a network of colourless threads with numerous large irregular white lime-knots, some of which may coalesce to form a pseudocolumella. Spores purple-brown, spinulose, 8 to 10  $\mu$  diam. Macbr. N. Am. Slime-Moulds, 32. *Diderma brunneolum* Phill. in Grev., v. 114 (1877); see note under *Craterium pedunculatum* Trentep., Lister Mycetozoa, 71.

Pl. 69.—*a*, *b*. sporangia from Portugal and California; *c*. capillitium and spores, with fragment of sporangium-wall; *d*. spore.

This species resembles *Craterium minutum* Fr. in the texture and colour of the sporangium-wall, but differs strikingly in having no lid, as well as in the more delicate capillitium threads, and rougher spores. The type specimen, marked *Diderma brunneolum* in Phillips' herbarium, was gathered in California by Dr. Harkness in 1877, and consisted of sessile sporangia only. Since then this species has twice been collected in Portugal by Dr. C. Torrend, who found it on dead leaves of *Agave americana* and on fir bark, with both stalked and sessile sporangia.

*Hab.* On dead bark and leaves.—California (B.M. slide); Portugal (B.M. 2154).

30. *P. nucleatum* Rex in Proc. Acad. Nat. Sci. Phil., 1891, 389. Plasmodium? Total height 1 to 2 mm. Sporangia globose, stalked, erect or inclined, 0.5 mm. diam., white, rarely iridescent from absence of lime; sporangium-wall membranous, with scattered included clusters of white lime-granules. Stalk

subulate or nearly cylindrical, 0·7 to 1·5 mm. long, longitudinally rugose, pale buff or yellow, translucent above, without deposits of lime, enclosing refuse matter at the base. Columella none. Capillitium a close persistent network of very slender colourless threads with scattered minute rounded white lime-knots; in the centre of the capillitium is usually suspended a shining white calcareous ball, 0·1 to 0·15 mm. diam., sometimes replaced by a cluster of irregular lime-knots; lime-granules, 1 to 2  $\mu$  diam. Spores pale violet-brown, minutely spinulose. 6 to 7  $\mu$  diam.—Macbride N. Am. Slime-Moulds, 54; *P. simile* Rost. Mon., App. p. 6 (1876) ?; Mass. Mon., 286?

Pl. 35.—*a.* sporangia (Philadelphia); *b.* capillitium showing the central calcareous ball surrounded by small lime-knots; *c.* spore.

The type specimen of *P. simile* Rost., from Curtis, South Carolina (K. 1255), has buff stalks without lime deposits, and delicate persistent capillitium with a central mass of lime; it is a poor development and in imperfect preservation; perhaps it should be referred to the present species, although Rostafinski's description of *P. simile* with the stalk continued into the sporangium as a cylindrical columella would apply better to *P. globuliferum* (see Rost. Mon., App. p. 6).

*Hab.* On dead wood.—Philadelphia (B.M. 2155); Iowa (B.M. 1019); Antigua (B.M. slide); Java (B.M. 2156); Borneo (B.M. 2157); Japan (B.M. 1991).

**31. *P. straminipes*** Lister in Journ. Bot., xxxvi. 163, t. 386, fig. 2 (1898). Plasmodium milk-white. Sporangia greyish-white, obovoid or wedge-shaped, 0·7 mm. diam., clustered or scattered, on long or short stalks, two or more often borne on a single stalk, or sessile and subglobose or irregularly ellipsoid; sporangium-wall colourless or pale purple, membranous, rather firm, with dense included clusters of lime-granules. Stalks straw-coloured, translucent, often 2 mm. long, membranous or cartilaginous, flattened or filiform, free from refuse matter, often continued below into a strand-like hypothallus. Capillitium a persistent network of stout rigid hyaline threads with expansions at the axils, and numerous rounded white lime-knots, some of which often unite to form a pseudocolumella. Spores 10 to 11  $\mu$  diam., purple-brown, marked with broad patches of warts separated by smoother tracts.—Torrend Fl. Myx., 197.

Pl. 42.—*a.* sporangia (Lyne Regis); *b.* capillitium and spores; *c.* spore.

Allied to *P. compressum*, but distinguished by the long slender translucent stalks, the rigid capillitium, and the peculiar distribution of warts on the spores.

*Hab.* On dead leaves, straw, etc.—Beds (B.M. 1709); Lyne Regis (B.M. 1700); Norfolk (B.M. 2163); Somerset (B.M. 2164); Aberdeen (B.M. 2165); Berlin (B.M. 2166).

**32. *P. pusillum*** Lister. Plasmodium watery-white. Total height 1 to 2 mm. Sporangia subglobose, rarely obovoid

or lenticular, stalked, erect or somewhat inclined, scattered, 0.4 to 0.6 mm. diam., white with a reddish base, rugose; sporangium-wall membranous, colourless above, with dense clusters of included white granules, thickened and rufous at the base. Stalk subulate or cylindrical, furrowed, 0.5 to 1.5 mm. long, red-brown, free from refuse matter. Columella none. Capillitium a network of colourless branching threads with lime-knots often varying in the same development; they are either small and few, or large branching and numerous, or approaching the type of *Badhamia*. Spores pale brownish-violet, almost smooth, 8 to 11  $\mu$  diam.—*Didymium pusillum* Berk. & Curt. in Grev., ii. 53 (1873). *Physarum nodulosum* Cooke & Balf., Rav. N. Amer. Fung., no. 479 (1881) (undescribed); Macbr. N. Am. Slime-Moulds, 51 (1899). *P. calidris* Lister in Journ. Bot., xxix. 258 (1891); Lister Mycetozoa, 52. *P. gravidum* Morg. Myx. Miami Valley, 96 (1896). *Badhamia nodulosa* Mass. in Journ. Myc., v. 186 (1889); Mass. Mon., 322. *Craterium nodulosum* Morg. l.c., 15.

Pl. 43.—*a.* sporangia (Bedfordshire); *b.* capillitium and spores of the same; *c.* sporangia of stouter form (Wanstead, Essex); *d.* capillitium and spores of the same; *e.* spore.

*P. pusillum* in its various forms, shows amongst the species of *Physarum* with white lime-granules a striking resemblance to the group *P. flavicomum*, *P. Maydis* and *P. auriscalpium* amongst the species with yellow lime-granules, while the short-stalked form of *P. pusillum* with *Badhamia*-like capillitium merges into *Badhamia panicea* as *P. auriscalpium* merges into *Badhamia decipiens*. The specimen from South Carolina in the Kew Herbarium, K. 1492, contains the type of this species. It consists of two specimens on two slips of wood marked "*Didymium pusillum*." On one slip is the present species, described by Berkeley under this name in Grev. l.c. On the other are a few sporangia of *D. nigripes* var. *xanthopus*; these exactly resemble the type of *D. proximum* Berk. (= *D. nigripes* Fr. var. *xanthopus*), also from South Carolina. Confusion has arisen owing to this inadvertent combination of two species, with the result that Rostafinski gives *D. pusillum* as a synonym for *D. proximum* (Rost. Mon., App. p. 23), only noticing the characters of the latter. The specimen from Broome's Herb. named *P. elephantinum* Berk. & Br. in MS., from Ceylon (B.M. 453), is a large form of the present species, with capillitium and spores similar to those in the English gatherings. *P. nodulosum* Cooke & Balf. (B.M. 858) from South Carolina is also *P. pusillum*, but has almost *Badhamia*-like capillitium.

*Hab.* On dead leaves, twigs, straw, etc.; frequent.—Lyme Regis (B.M. 1237); Bedfordshire (B.M. 1703); Northants (K. 1549); Linlithgow (K. 1504); Montpellier (B.M. 2168); Parma (B.M. 496); Portugal (B.M. 2173); Switzerland (Herb. Zürich); Germany (B.M. 2169); Nielgherries (K. 1531); Ceylon (B.M. 453); Java (B.M. 2170); New Zealand (B.M. 2171); Japan (B.M. 2172); South Carolina (B.M. 858); Antigua (B.M. 1650); Bolivia (B.M. 2174).

33. *P. didermoides* Rost. Mon., p. 97, fig. 87 (1875). Plasmodium white. Total height 0.5 to 1.3 mm. Sporangia

stalked, erect and ovoid, about 0.8 mm. high, 0.5 mm. broad, or sessile, ovoid or subglobose, crowded, white, or dark grey above from the falling away or discontinuance of the outer calcareous crust; sporangium-wall of three layers, the outer a dense deciduous deposit of white lime-granules, the middle layer a delicate colourless membrane with scattered lime-granules, closely combined with an inner purplish, areolated, thicker layer. Stalk variable in length and thickness, white, membranous, not containing refuse matter and rarely enclosing lime-granules, rising from a plicate white hypothallus. Columella none. Capillitium consisting of numerous rounded white lime-knots connected by short, seldom branching hyaline threads, which are purple at the attachments to the sporangium-wall. Spores very dark purple-brown, closely and minutely spinulose, 10 to 13  $\mu$  diam.—Mass. Mon., 291; Macbride N. Am. Slime-Moulds, 40. *Spumaria*? *didermoides* Acharius in Pers. Syn., Addenda xxix. (1801). *Physarum conglobatum* Fr. Symb. Gast., 21 (1818)? *P. lividum*  $\beta$  *licheniforme* Rost. Mon., p. 96; Mass. Mon., 304 (in part). *P. cinereum* var. *ovoideum* Sacc. in Michelia, ii. 334 (1882); Mass. Mon., 299. *P. platense* Speg. in Ann. Mus. Nac. Buen. Aires, vi. 199 (1899)? *Spumaria licheniformis* Schwein. in Trans. Amer. Phil. Soc., n.s. iv. 261 (1832). *Claustria didermoides* Fr. Summ. Veg. Scand., ii. 451 (1849). *Didymium congestum* Berk. & Br. in Ann. Mag. N.H., ser. 2 v. 365 (1850). *Badhamia*? *pulcherrima* Speg. in B. Acad. Nac. Cienc. Cord., xi. 474 (1889)?

Var. *lividum* Lister, differs from the type in the grey sporangia being always sessile and having usually a single layer only to the sporangium-wall, in the lime-knots being more angular, and in the rougher purple-black spores being paler and smoother on one side.—Lister in Journ. Bot., xxxvi. 161 (1898).

Pl. 45.—*a.* sporangia (Flitwick, Beds); *b.* capillitium and spores, with fragment of sporangium-wall; *c.* spore.

Pl. 46.—var. *lividum*; *a.* sporangia (Flitwick, Beds); *b.* capillitium and spores, with fragment of sporangium-wall; *c.* spore.

*P. cinereum* var. *ovoideum* Sacc. on *Ailanthus glandulosa* from Lyon, leg. J. Therry (B.M. 432), is a short-stalked form of *P. didermoides*, with sporangia arising from a white membranous hypothallus. *P. lividum* var. *licheniforme* Rost., portions of the type of which from South Carolina are in the Strassburg and Kew collections, is a sessile form of *P. didermoides*. The var. *lividum* has hitherto been recorded only from the county of Bedfordshire in this country. It was first observed in April, 1897, on heaps of old straw near Luton by Mr. James Saunders, who has since found it in half-a-dozen stations in that neighbourhood; it appears almost every year during the summer and autumn months, often in great profusion, upon neglected straw heaps, sometimes in company with the typical form. A specimen gathered near Lisbon by

Dr. C. Torrend among dead twigs appears to be intermediate between the type and var. *lividum*; the sessile globose sporangia have firm but single walls, and the lime-knots are rather angular, while the spores are dark brown and traversed by a band almost free from warts. Another gathering by Dr. Torrend, from Cintra, resembles typical *P. didermoides* in all respects except that the stalks are cylindrical and charged with white lime-granules throughout. (Compare *P. testaceum* Sturg., p. 79.)

*Hab.* On dead wood, leaves, or old straw.—Bedfordshire (B.M. 2175); Somerset (B.M. 2176); Hampshire (B.M. 2177); Lyons, France (B.M. 432); Germany (B.M. 2178); Sweden (B.M. 2180); Portugal (B.M. 2179); Cameroons (Herb. Dr. Jahn); Ceylon (B.M. 420); Java (B.M. 2181); Japan (B.M. 2182); Iowa (B.M. 809); Ohio (B.M. 1242); North Carolina (B.M. 998); Brazil (B.M. 2184); var. *lividum*—Bedfordshire (B.M. 1696); Portugal (B.M. 2183).

34. *P. nutans* Pers. in Usteri Ann. Bot., xv. 6 (1795). Plasmodium watery white, or yellowish-grey from the presence of foreign matter. Total height 1 to 1.5 mm. Sporangia stalked, erect or nodding, subglobose or lenticular, more or less flattened or concave beneath, 0.4 to 0.7 mm. broad, white, greyish-white, or violet-grey, gregarious; sporangium-wall membranous, with included minute white granules in more or less dense clusters. Stalk subulate, longitudinally wrinkled, grey, yellowish, olivaceous or black, translucent above, sometimes opaque and white from deposits of lime in the wall, the tube of the stalk containing refuse matter but not lime. Capillitium consisting of slender colourless threads, branching at an acute angle and anastomosing, with few flat expansions at the axils and few small white lime-knots. Spores clear brownish-violet, nearly smooth or minutely spinulose, 8 to 10  $\mu$  diam.—Fr. Syst. Myc., iii. 128. *Sphaerocarpus albus* Bull. Champ., 137, t. 407, fig. 3, t. 470, fig. 1, A to G (1791). *Stemonitis alba* Gmel. Syst. Nat., 1469 (1791). *P. bulbiforme* Schum. Enum. Pl. Saell., ii. 200 (1803). *P. albo-punctatum* Schum. l.c., 200. *P. Didymium* Schum. l.c., 202? *P. marginatum* Schum. l.c., 202? *P. Pini* Schum. l.c., 203. *P. solutum* Schum. l.c., 204? *P. furfuraceum* Schum. l.c. *P. albipes* Link in Mag. Ges. Nat. Fr. Berl., iii. 27 (1809)? *P. sulcatum* Link l.c., 27? *P. connatum* Ditm. in Sturm Deutsch. Fl., Pilze, 83, t. 41 (1817)? *P. gracilentum* Fr. l.c., 133 (1829). *P. cernuum* Fr. l.c., 130. *Trichia nutans* Trentep. in Roth Catal. Bot., i. 227 (1797). *T. cernua* Schum. l.c., 211. *Didymium marginatum* Fr. l.c., 115. *D. furfuraceum* Fr. l.c., 116. *Tilmadoche cernua* Fr. Summ. Veg. Scand., 454 (1849). *T. nutans* Rost. Mon., p. 127 (1875); Mass. Mon., 327. *T. Pini* Rost. l.c., 128. *T. gracilenta* Rost. l.c., 129; Mass. l.c., 330. *T. anomala* Mass. l.c., 333? *T. alba* Macbr. N. Am. Slime-Moulds, 58 (1899).

Subsp. *leucophaeum* Lister: sporangia usually erect, 0.5 to 1 mm. diam., stalked, sessile or forming plasmodiocarps;

stalks stouter, rarely containing lime ; columella occasionally present as an irregular or conical continuation of the stalk into the sporangium ; capillitium usually more rigid than in the type, with broad expansions at the axils and large, often branching lime-knots that are sometimes confluent in the centre of the sporangium ; spores 9 to 11  $\mu$ .—*Physarum leucophaeum* Fr. Symb. Gast., 24 (1818) ; Rost. Mon., p. 113, figs. 77, 78, 89 ; Mass. Mon., 288 ; Macbr. N. Am. Slime-Moulds, 44. *P. confluens* Link in Mag. Ges. Nat. Fr. Berl., vii. 43 (1815) ? *P. hypnorum* Link l.c., 43 ? *P. connexum* Link l.c., iii. 28 (1809) ? *P. conglobatum* Ditm. in Sturm Deutsch. Fl., Pilze, 81, t. 40 (1817). *P. albipes* de Bary in Zeitschr. Wiss. Zool., x. 95 (1860). *P. granulatum* Balf. in Grev., x. 115 (1882) ; Mass. l.c., 289. *P. imitans* Racib. in Rozpr., Mat.-Przyr. Acad. Krak., xii. 73 (1884). *P. Readeri* Mass. l.c., 282. *Sphaerocarpus albus* Bull. Champ., 137, t. 470 H to L (1791). *Trichia filamentosa* Trentep. in Roth Catal. Bot., i. 227 (1797). *Tilmadoche nephroidea* Cel. fil. Myx. Böhm., 69 (1893).

Pl. 37.—*a.* sporangia (Essex) ; *b.* capillitium and spores ; *c.* spore ; *d.* *d.* sporangia intermediate between the typical form and sub-species *leucophaeum* (Essex) ; *e.* capillitium of *d.*, with abundant lime-knots ; *f.* capillitium of *d.* with few small lime-knots.

Pl. 38.—*a.* sporangia of subsp. *leucophaeum* (Essex) ; *b.* capillitium and spores of the same ; *c.* robust sporangia, with much lime in the walls ; *d.* capillitium and spores of *c.* ; *e.* spore.

An extremely variable and abundant species. The stalked and plasmodiocarp forms may develop from the same growth of plasmodium ; sporangia may be found with delicate capillitium and few minute lime-knots, associated with others from the same plasmodium with wide expansions at the angles of the threads and with large lime-knots ; some may have erect stalks enclosing much refuse, standing with others more weakly formed, containing little refuse matter and cernuous from the weight of the sporangium. As in all the *Calcarineae* the amount of lime in the sporangium-wall is liable to great variation ; where the supply is abundant it gives firmness and persistence to the membrane ; where it is scanty the wall is fragile or evanescent, as in the form named by Rostafinski *Tilmadoche nutans*. In contrast with the latter, a robust form occurs, having a short stout stalk, often projecting within the sporangium in a conical point, with lime-knots of large size, either distributed among the capillitium or confluent in the centre ; between these extreme forms all shades of difference may be found, making it difficult to define even distinct varieties. Examination of a large series leads to the conclusion that *P. leucophaeum* is not a distinct species, but must be included under *P. nutans*. The specimen of *T. gracilentia* Rost. from Poland in the Strassburg collection is a minute form of *P. nutans* with small, nearly globose sporangia of a greyish-white or greyish-violet colour, as described in Rostafinski's monograph, and not "*jusco-atra*" as given in Sacc. Syll., vii. p. 360. The type of *Physarum Readeri* Mass., from Melbourne (K. 500), is the subsp. *leucophaeum*, with spores 8 to 9  $\mu$  diam. (not 15 to 16  $\mu$ ). The type of *P. granulatum* Balf. fil. (K. 67) is the same subspecies with the lime of the sporangium-wall in sand-like granules, a not infrequent modification in species of

*Physaraceae* (cf. *P. compressum*). *P. musicola* Pers. is referred to by Persoon in Syn. Fung. 171 (1801) as hardly to be distinguished from the somewhat larger species *P. nutans*: it may therefore be included here, as may also *Tilmadoche Pini* Rost., which is described as similar to *P. nutans* but of erect and somewhat larger more robust growth.

*Hab.* On dead wood and leaves.—Wanstead, Essex (B.M. 1230); Lyme Regis, Dorset (B.M. 1232); Sweden (B.M. 2185); Germany (B.M. 500); Italy (B.M. 498); Portugal (B.M. 2186); Ceylon (B.M. 2187); Philippine Islands (B.M. 2034); Japan (B.M. 1990); Maine, U.S.A. (B.M. 1593): subsp. *leucophaeum*—Lyme Regis (B.M. 1233); Brentwood, Essex (B.M. 1234); Staffordshire (B.M. 1235); North Ireland (B.M. 2188); Baden (B.M. 497); Bohemia (B.M. 2189); Australia (K. 500); Maine (B.M. 1236).

35. *P. javanicum* Racib. in Hedw., xxxvii. 53. (1898). Plasmodium? Sporangia scattered, stalked, orbicular, flattened or somewhat convex below, umbilicate above, 0.6 to 0.8 mm. diam., 0.25 mm. thick, greyish-white; sporangium-wall membranous with evenly distributed lime-granules, fragile and fugacious above with a more persistent base. Stalk subulate, slender, flexuose, 1.5 to 1.8 mm. high, greyish-white or pale straw-coloured above, darker from included refuse matter below. Capillitium a lax network of rather rigid threads with long fusiform and branching white lime-knots, or almost *Badhamia*-like and consisting of a network of branching tubes filled with lime-granules and attached to the sporangium-walls by straight hyaline threads. Spores greyish violet, nearly smooth, 10  $\mu$  diam.—Penzig Myxom. Buit., 30 (1898).

Pl. 197.—*a.* sporangia; *b.* capillitium, with fragment of sporangium-wall; *c.* spore; (Java)

This graceful species is said to be common around Buitenzorg and not unfrequent at Tjibodas in the Island of Java. It appears to be closely allied to *P. nutans*, differing in the shape of the sporangia and the more rigid capillitium. It bears considerable resemblance to *Trichamphora pezizoidea* Jungh., but the sporangia are more umbilicate, less saucer-shaped, and the colour of the stalks is pale straw-coloured instead of dark red.

*Hab.* On dead wood.—Java (B.M. 2190).

36. *P. crateriforme* Petch in Ann. R. Bot. Gard. Perad., iv. 304 (1909). Plasmodium? Sporangia scattered or in groups, greyish-white, either cylindrical, obovoid, spherical or reniform, sometimes depressed, stalked or occasionally sessile; sporangium-wall membranous with clustered deposits of white lime-granules. Stalk conical, black, or black below and white above, opaque from included refuse matter, 0.1 to 0.7 mm. long. Columella variable in colour and shape, white, yellow-brown or black, cylindrical and reaching to the apex of the sporangium, or ending short

of it and then clavate or shortly conical, sometimes absent. Lime-knots either united to form a massive columella giving off horizontal spike-like points which end in simple or forked hyaline threads uniting with the sporangium-wall, or in the spherical sporangia branched and forming an almost *Badhamia*-like network with few connecting threads. Spores violet-brown, closely spinulose, 10–13  $\mu$  diam.—Petch l.c., 336.

Pl. 76.—*a. b.* sporangia of various shapes; some sporangia in *b.* have no columella (Ceylon); *c.* sporangium with spores dispersed showing columella; *d.* apex of columella; *e.* capillitium from sporangium without columella; *f.* spore.

In this variable species a single development may show ovoid, globose and reniform sporangia; the columella may reach and expand into the upper sporangium-wall and the capillitium show scanty fusiform lime-knots, or the columella may be absent and the lime-knots abundant. When spherical sporangia appear alone they closely resemble *P. nutans* subsp. *leucophaeum*, but may be distinguished by the laxer net of the capillitium, the more branched lime-knots, and the rather larger spores.

*Hab.* On dead wood.—Lisbon (B.M. 2193); Ceylon (B.M. 2191) Japan (B.M. 2192); Antigua (B.M. slide).

**36. *P. compressum*** Alb. & Schw. Consp. Fung. 97 (1805). Plasmodium white. Total height 1 to 1.5 mm. Sporangia reniform, or obovoid, compressed, erect, splitting along the ridge remote from the base, stalked, sessile, or forming plasmodiocarps, scattered, closely aggregated or confluent, white or grey, rugose or warted; sporangium-wall membranous, colourless or purplish below, including dense clusters of white lime-granules that appear under a low magnification as thickly-set white spots. Stalk stout, equal, furrowed, black from contained refuse matter, or brownish, or white from deposits of lime in the wall, never with a chalk-white fracture at the base. Columella none. Capillitium a close network, with numerous rounded white lime-knots varying in shape and size, connected by rather short seldom branching hyaline threads. Spores dark purplish-brown, more or less spinulose or echinulate, 9 to 14  $\mu$  diam.—Sacc. Syll., vii. 337. *P. griseum* Link in Mag. Ges. Nat. Fr. Berl., iii. 27 (1809)? *P. nephroideum* Rost. Mon., p. 93, figs. 80 to 82; Mass. Mon., 285; Macbr. N. Am. Slime-Moulds, 41, in part. *P. candidum* Rost. l.c., p. 96. *P. affine* Rost. l.c., App. p. 5. *P. lividum* var. *conglobatum* Rost. l.c., p. 95, in part. *P. Phillipsii* Balf. fil. in Grev., x. 116 (1882). *P. glaucum* Mass. l.c., 284. *Didymium glaucum* Phill. in Grev., v. 114 (1876).

Pl. 39.—*a.* sporangia of various shapes developed from the same plasmodium (Hertfordshire); *b.* capillitium and spores; *c.* spore.

Pl. 40.—*a.* sporangia from the type of *P. Phillipsii*; *b.* capillitium and spores.

The sporangia of this abundant species vary extremely in shape and general appearance. In some forms they resemble those of the following allied species, from which they may be distinguished by the following



characters: from *P. nutans* by the abundant lime-knots and darker spores; from *P. vernum* the sessile forms are separated by the more compressed sporangia and darker spores; from *P. didermoides* by the presence of refuse matter in the stalk and by the single sporangium-wall; from *P. sinuosum* by the darker spores and shorter plasmodiocarps. For other allied species, see *P. straminipes*, *P. connatum*, and *P. reniforme*. Much difference is found in the size and roughness of the spores in sporangia from the same cultivation; in some they measure 12 to 15  $\mu$ , and are strongly spinulose, while in others they are smoother, and average 9 to 11  $\mu$  diam. The spines are usually evenly distributed, but are sometimes grouped in patches separated by narrow smoother tracts, which gives the spore a faceted appearance, but this feature is never so marked as in *P. straminipes*. The granules in the sporangium-wall frequently coalesce into vitreous superficial scales or coarse particles, and those in the lime-knots become transparent and lose their granular character; this feature is also met with in other species of *Physarum*. In preparations in water of highly calcareous sporangia part of the solid matter is found to dissolve, and, on drying, to crystallise on the slide in particles resembling those described. A cultivation from an extensive growth of plasmodium exhibited the forms  $\alpha$ ,  $\beta$ , and  $\gamma$  in the development of the sporangia:

$\alpha$ . Sporangia obovoid or reniform, laterally compressed, on short black or grey stalks, or sessile.

$\beta$ . Sporangia obovoid or reniform, on white stalks 0.5 mm. long.

$\gamma$ . Plasmodiocarps lobed and confluent.

The specimens named *P. nephroideum* Rost. (Strassb. Herb.) are the form  $\alpha$ . The type of *P. candidum* Rost., from Juan Fernandez (K. 510), is the form  $\beta$ ; in some of the sporangia the lime-knots coalesce to form a central mass; that of *P. Phillipsii* Balf., from Phillips' Herb., shows the forms  $\alpha$  and  $\gamma$ ; and that of *P. lividum* var. *conglobatum* Rost., from Ceylon, no. 55 (K. 1244), is the form  $\alpha$  with short black stalks; that of *P. affine* Rost., from Cuba, no. 907 (K. 1350), is the form  $\beta$  with white stalks. The specimen named *Didymium botryoides* Berk. in Herb., from New Zealand (K. 1523)—named by Massee *D. radiatum* B. & C.—is the form  $\alpha$ . *D. pruinatum* Berk. & Curt., from Cuba (K. 1515), given by Rostafinski as a synonym for *P. nephroideum* (Rost., App., p. 5), is the form  $\alpha$ . The type of *Didymium glaucum* Phill. from California is form  $\alpha$ ; the sporangia are either on short black stalks or sessile.

*Hab.* On dead leaves, twigs, straw, etc.—Bedfordshire (B.M. 1238); Hertfordshire (B.M. 1239); Shrewsbury (B.M. 115); Birmingham (B.M. 1240); Forres (K. 106); Sweden (B.M. 2195); near Paris (B.M. 2197); near Berlin (B.M. 1050); Italy (B.M. 423); Portugal (B.M. 2196); Ceylon (B.M. 419); Australia (K. 1314); New Zealand (B.M. 2198); Philippine Islands (B.M. 2041); Japan (B.M. 2199); Colorado (B.M. 2200); Philadelphia (B.M. 2201); Dominica (B.M. 1651A); Brazil (B.M. 1779).

38. *P. connatum* Lister (*non* Ditm.) Plasmodium white. Sporangia stalked, scattered and free, or grouped in clusters of two or more, globose, turbinate or reniform, greyish-white, 0.5 to 0.7 mm. diam.; sporangium-wall membranous with clustered deposits of lime-granules, rarely iridescent and almost free from lime. Stalk stout, furrowed, dark or

pale brown, buff or whitish, 0.1 to 0.7 mm. long, opaque with enclosed refuse matter. Capillitium a network of flexuose hyaline threads with numerous rounded or angular white lime-knots. Spores purple-brown, minutely spinulose, 10 to 11  $\mu$  diam. *Didymium connatum* Peek in Rep. N.Y. Mus., xxvi. 74 (1874); Sturgis in Trans. Conn. Acad., x. 477 (1900). *Physarum connexum* Link, Morg. Myx. Miami Valley, 92 (1896). *P. compressum* var.  $\delta$ , Lister Mycetozoa, 54 (1894). *P. nephroideum* Rost., Macbr. N. Am. Slime-Moulds, 41 (1899), in part. *P. tropicale* Macbr. l.c., 45.

Pl. 40.—*c.* sporangia (Iowa); *d.* capillitium and spores; *e.* spore.

This species is referred to by Dr. Sturgis (l.c.) as being one of the commonest of northern New England, and is abundant also in the central and western United States. In the old world it has been obtained in England and Sweden. Although very nearly allied to *P. compressum* it may be distinguished by the sporangia being more symmetrical and not compressed, and by the more angular lime-knots. *P. tropicale* Macbr. is a rather large form of the present species with little lime in the iridescent sporangium-walls and in the capillitium.

*Hab.* On dead wood.—Bedfordshire (B.M. 2202); near Upsala (B.M. 2203); Maine, U.S.A. (B.M. 1589); Iowa (B.M. 806); Mexico (B.M. 2204).

**39. *P. reniforme*** Lister. Plasmodium? Sporangia scattered or clustered, stalked or almost sessile, reniform, obconic, bolster-shaped or lobed, usually compressed, 0.4 to 0.9 mm. diam., often confluent in clusters of from three to twenty or more, greyish-white; sporangium-wall membranous, with clustered deposits of lime-granules. Stalk wrinkled, variable in colour, either pale yellow, yellow-brown, or fuscous, usually rather slender and flexuose, 0.3 to 1 mm. long, enclosing refuse matter at the base. Capillitium with short hyaline threads connecting the numerous angular lime-knots that are often united to form a pseudo-columella, sometimes almost *Badhamia*-like. Spores brownish-purple, either faintly or strongly spinulose, 9 to 15  $\mu$  diam.—*Til-madoche reniformis* Mass. Mon., 336 (1892). *Didymium echinospora* Mass. l.c., 239. *Physarum nicaraguense* Macbr. in Bull. Nat. Hist. Iowa, ii. 382 (1893), & N. Am. Slime-Moulds, 43; Petch in Ann., Perad., iv. 334. *P. compressum* Alb. & Schw., Lister Mycetozoa, 54, in part (1894).

Pl. 41.—*a.* sporangia (Nicaragua); *b.* capillitium and spores; *c.* spore.

This species, like the last, is nearly allied to *P. compressum*. It has now been obtained from many parts of the world retaining the following distinctive features:—the sporangia are smaller and more clustered than in *P. compressum*, the stalks are more slender, and the capillitium is often so densely charged with lime as to assume almost a *Badhamia* character. In the type from Ceylon (K. 1406) and in *Didymium echinospora* Mass., also from Ceylon (K. 1407), the sporangia are reniform

or lobed, with slender brown stalks, and with spores 12 to 15  $\mu$  equally spinose all over. In extensive gatherings made by Mr. T. Petch at Peradeniya, Ceylon, where the species is fairly common, the sporangia are either single or massed together in large clusters, the spores average 10  $\mu$ , and are often faceted with patches of warts separated by smoother tracts somewhat as in *P. stramineipes*. Mr. K. Minakata sends from Japan a specimen (B.M. 2205) similar to the type in every respect, except that the spores show something of "facetting." The type of *P. nicaraguense* Macbr. is very similar to Mr. Petch's gatherings, but the spores, which measure 9 to 11  $\mu$ , have the spinules evenly distributed.

It appears possible that *Physarum fasciculatum* Jungh. (Fl. Crypt. Java, 11, pl. 2, fig. 8, 1838, syn. *Badhamia fasciculata* Rost. Mon., App. p. 2), may have been the present species. It is described as having globose white sporangia, dehiscing irregularly, fugacious above, persistent below; stalks connected in clusters of three to six or more, erect, tough, dirty yellowish, attenuated upwards; capillitium of tubes as in *Badhamia*; spores violet, smooth, 11 to 12  $\mu$ . Specimens of *P. reniforme* gathered in Java by Prof. Penzig and recorded by him as *Badhamia fasciculata* (Myx. Buit., 18) agree with the above description, except that the sporangia are obconic, and the capillitium is more that of a *Physarum*, having the large branching lime-knots connected by short hyaline threads.

*Hab.* On dead wood.—Ceylon (B.M. 420); Japan (B.M. 2205); Philippine Islands (B.M. 2044); Java (B.M. 2330); Nicaragua (B.M. 1010).

40. *P. cinereum* Pers. in Roemer N. Mag. Bot., i. 89 (1794). Plasmodium watery-white. Sporangia sessile, subglobose, pulvinate, heaped, crowded or scattered, or forming simple or branched plasmodiocarps, 0.3 to 0.5 mm. broad, cinereous, more or less warted or veined with white; sporangium-wall membranous with included clusters of white lime-granules. Columella none. Capillitium of branching hyaline threads, with numerous white lime-knots varying in size and shape, sometimes forming a *Badhamia*-like network with few hyaline threads. Spores bright violet-brown, almost smooth or spinulose, 7 to 10  $\mu$  diam.—Rost. Mon., p. 102, figs. 71, 72, 85; Mass. Mon., 298; Macbr. N. Am. Slime-Moulds, 34. *Lycoperdon cinereum* Batsch Elench. Fung., 155 (1783). *Trichia coerulea* Trentep. in Roth Catal. Bot., i. 229 (1797)? *Physarum violaceum* Schum. Enum. Pl. Saell., ii. 199 (1803)? *P. plumbeum* Fr. Syst. Myc., iii. 142 (1829); Morg. Myx. Miami Valley, 98 (1896); Macbr. N. Am. Slime-Moulds, 35. *P. capense* Rost. Mon., p. 113, fig. 93 (1875)? *P. scrobiculatum* Mass. l.c., 300. *Didymium cinereum* Fr. l.c., 126. *D. scrobiculatum* Berk. in Hook. Lond. Journ. Bot., iv. 66 (1845). *D. oxalinum* Peck in Rep. N.Y. State Mus., xxxi. 41 (1879).

Pl. 47.—a. sporangia (Essex); b. capillitium and spores; c. spore.

This widely distributed species is often abundant on dead leaves, fir needles, or in heaps of old straw. It appears to merge naturally

by many intermediate gatherings into *P. vernum* Somm., which perhaps is hardly more than a very robust variety with larger, darker spores. When the sporangia are clustered and nearly destitute of lime, *P. cinereum* is with difficulty distinguishable from *P. atrum* Schwein. (q.v.). *Physarum conglobatum* Ditm. (in Sturm Deutsch. Fl., Pilze, i. 40; Fr. Syst. Myc., iii. 142) has been placed by Rostafinski as a synonym for the present species; but the descriptions are too imperfect to be instructive. From Berkeley's description of *Didymium scrobiculatum*. Rostafinski was probably right in placing it under *P. cinereum*; hardly anything remains of the type from Swan River, Australia, in Berkeley's Herb. (K. 1518).

*Hab.* On dead leaves, etc.—Devon (B.M. 1244); Essex (B.M. 1243); Bedfordshire (B.M. 2208); Wiltshire (2207); Aberdeen (B.M. 2211); France (Paris Herb.); near Berlin (B.M. 2209); Sweden (B.M. 2210); Portugal (B.M. 2212); Italy (B.M. 1972); Ceylon (K. 1284); New South Wales (B.M. 2213); New Zealand (2214); Philippine Islands (B.M. 2032); Japan (B.M. 2215); Pennsylvania (B.M. 1246); Iowa (B.M. 1245); South Carolina (B.M. 431); Brazil B.M. 2216); Antigua (B.M. 1652).

41. *P. atrum* Schwein. in Trans. Am. Phil. Soc., n.s. iv. 258 (1832). Plasmodium yellow, or white? Sporangia subglobose, 0.2 to 0.4 mm. diam., sessile, confluent, clustered or heaped, dull violet-brown, often veined with white or sprinkled with minute white warts; sporangium-wall membranous, pale purplish, with or without scanty deposits of lime. Capillitium a sparse network of hyaline threads with small angular or branching white lime-knots. Spores brownish-violet, minutely warted, 10 to 12  $\mu$  diam.—Morg. Myx. Miami Valley, 99 (1896); Macbr. N. Am. Slime-Moulds, 36. *P. reticulatum* Berl. in Sacc. Syll. Fung., vii. 350 (1888).

Pl. 64.—*a.* sporangia (New Brunswick); *b.* capillitium and spores with fragment of sporangium-wall; *c.* spore.

It has been doubted if this is a distinct species, or if it may not be a large-spored and almost limeless form in some cases of *P. cinereum* in others of *P. virescens*. The late Dr. Rex, who had wide experience of North American Mycetozoa, wrote of it in 1892: "This, though found in some quantity was probably abnormal; I think it is probably *P. virescens* with a minimum of lime." Prof. Farlow, writing in 1902, observes that in July of that year, "this was by far the commonest species on moss, dead leaves and twigs, in the fir woods on Campobello Island, New Brunswick"; he adds that the plasmodium was yellow, but does not express a decided opinion as to the validity of *P. atrum* as a species. Dr. Jahn has repeatedly gathered a similar form in woods near Berlin, arising from white plasmodium. The capillitium is often entirely limeless. With our present imperfect knowledge, it would seem well for convenience to recognise Schweinitz's species; *P. atrum* here includes both the German and American gatherings.

*Hab.* On dead wood, twigs, etc.—Berlin (B.M. 2277); New Brunswick (B.M. 2279); New Hants (B.M. 2278).

42. *P. vernum* Somm. in litt. ex Fr. Syst. Myc., iii. 146 (1829). Plasmodium white. Sporangia sessile, subglobose or forming short or elongated often crowded plasmodiocarps, greyish-white, 0.5 to 1 mm. diam., often several millimeters in length, rugulose; sporangium-wall membranous usually densely charged with lime-granules, sometimes iridescent from absence of lime. Capillitium consisting of short hyaline threads connecting numerous angular branching white lime-knots, that often unite in the centre to form a pseudo-columella. Spores purplish-brown, spinulose, 9 to 12  $\mu$  diam.—Lister in Journ. Bot., xxxv. 210. *Badhamia verna* Rost. Mon., p. 145 (1875), in part.

Pl. 48.—*a.* sporangia (Arolla, Switzerland); *b.* capillitium and spores; *c.* spore.

This species differs from *P. cinereum* to which it is very closely allied by the darker and usually larger spores. It is abundant in this country on heaps of dead leaves and old straw. The typical robust form, rich in calcareous deposits, and often forming long plasmodiocarps is one of the commonest species in the Swiss Alps in spring, where it occurs in company with *Diderma niveum* and *Lepidoderma Carestianum* on dead twigs, leaves and grass close to the edge of melting snow. A variety of *P. vernum* having small scattered sporangia, iridescent from absence of lime, but with abundant white lime-knots, appears almost every autumn in England and on the Continent; if it were not for the darker brown spores, this form would seem to be more nearly allied to *P. cinereum*.

*Hab.* On dead leaves and twigs, straw, etc.—Bedfordshire (B.M. 1699); Epping Forest (B.M. 1702); Christiania, part of type (B.M. 1701); Arolla, Switzerland (B.M. 2280); Jura Mountains (B.M. 2281); Austria (B.M. 2282); Portugal (B.M. 2283); Cuba (B.M. 429).

43. *P. gyrosum* Rost. Mon., p. 111 (1875), in part. Plasmodium creamy-white, or dull yellowish-white. Sporangia sessile, much compressed, clustered, forming rosettes or net-like plasmodiocarps one to many millimeters diam., pinkish grey, usually seated on a pink or dull red hypothallus; sporangium-wall membranous with clustered deposits of white or reddish lime-granules. Capillitium a scanty network of hyaline threads with numerous large white transversely placed fusiform or irregular lime-knots. Spores pale brownish-violet, minutely spinulose, 7 to 10  $\mu$  diam.—Mass. Mon., 307, in part; Lister in Journ. Bot., xl. 210, t. 438, fig. 2; Petch in Ann. R. Bot. Gard. Perad., iv. 339. *Liquidium reniforme* Fr. Sym. Gast., 10 (1817)? *Fuligo septica* Gmel., Lister Mycetozoa, 66 (1894), in part. *F. gyrosa* Jahn in Ber. Deutsch. Bot. Gesell., xx. 272 t. xiii, figs 3, 4 (1902).

Pl. 52.—*a.* rosette-like cluster of sporangia (Ceylon); *b.* capillitium and spores; *c.* spore.

In the first edition of the present work *P. gyrosum* was regarded as a form of *Fuligo septica*; gatherings from many parts of the world have since fully established its position as a distinct species. It appears

to be on the borderline between the genera *Physarum* and *Fuligo*; the sporangia are either simple, or form a net which may be regarded either as a much branched plasmodiocarp or as a small aethalium. Dr. Jahn describes his finding the sporangia repeatedly on earth and seedling plants in the forcing-houses of the Botanic Gardens, Berlin; it has also been found in the open air in Germany. Mr. T. Petch, writing from Ceylon, says, "I found one evening a creamy-white plasmodium emerging in small pillars about 1 cm. high from the sides of holes 6 inches deep on land prepared for planting cocoa. Next morning all the pillars had collapsed into small rosettes on a central pinkish hypothallus; with the exception of one piece on a blade of grass the sporangia were all formed on stone, pieces of glass and earth, and seemed to be in a continuous sheet, but they separated easily from each other." Mr. K. Minakata describes his finding the "pale sordid yellow" plasmodium of this species "on the perpendicular stone basement of an outhouse at Nakayama, Kii, Japan," forming a mass 6 cm. across, and 12 cm. above the surface of the ground. It has also been obtained from North and South America.

*Didymium daedalium* Berk. & Br. (in Ann. Mag. Nat. Hist., ser. 2, v. 366, 1850) is possibly the present species; the description is as follows:—"Sporangia connate, labyrinthine-sinuous, pale brick-red, of the same colour as the short connate stalks, sprinkled with white meal; floeci white; spores purple-black, smooth, globose. *Hab.* In great abundance in a cucumber frame.—Milton, Norths. Spreading far and wide in little globose masses; stems reddish-brown, inclining to orange, connate, as if composed of little flat bran-like membranes, sporangia having a greyish tinge from the contained spores, which are purple-black; variegated with the white floeci, which are frequently forked, and vary greatly in width, being in parts flat, broad, and membranous." In the absence of the type this reference must remain uncertain.

*Hab.* On earth, leaves, etc.—Berlin (B.M. 2285); Ceylon (B.M. 2287); Japan (B.M. 2284); New York (B.M. 1970); Brazil (B.M. 2286).

44. *P. Gulielmae* Penzig Myx. Buit., 34 (1898). Plasmodium yellow. Sporangia subglobose or reniform, sessile, about 0.4 mm. diam., brownish-orange or chestnut-brown, rugulose, clustered or heaped, often with a yellow membranous hypothallus; sporangium-wall membranous or somewhat cartilaginous, with abundant clustered deposits of browish-yellow lime-granules. Capillitium a network of hyaline threads with large white angular or branching lime-knots. Spores purple-brown, spinulose, 10 to 12  $\mu$  diam.—Torrend Fl. Myx., 182.

Pl. 63.—a. sporangia (Sweden); b. capillitium and spores, with fragment of sporangium-wall; c. spore.

Allied perhaps to *P. virescens* or possibly to *P. contextum*, but differing notably from both in the combination of brown sporangia and white lime-knots. Rostafinski's account of *P. Famintzini* (Mon., p. 107) which has apparently been found only once, in Poland, and having minute, crowded, dull chestnut sporangia and "milky yellow" lime-knots, applies fairly well to *P. Gulielmae*, but we have nothing in the

present species corresponding to the "elastic capillitium elongated after dehiscence" characterising *P. Famintzini*, the affinity of which, must in the absence of the type remain uncertain.

*Hab.* On twigs, herbaceous stems, etc.—Kiel, Germany (herb. Dr. R. Trilling); Sweden (B.M. 1941); Switzerland (B.M. 2288); Java (Herb. Penzig).

45. *P. echinosporum* Lister in Journ. Bot., xxxvii. 147, t. 398, fig. 1, *a, b, c* (1899). Plasmodium? Sporangia scattered, forming chalk-white usually curved plasmodiocarps, strongly compressed laterally, dehiscing along the thin upper ridge; sporangium-wall of two layers, the outer smooth, eggshell-like, charged with minute lime-granules, separating from the inner membranous iridescent pale purplish layer. Capillitium consisting of numerous smooth white lime-knots, irregular in shape and size, connected by short hyaline threads. Spores purple,  $8\mu$  diam., marked with strong ridges and spines.—Torrend Fl. Myx., 178.

Pl. 53.—*a.* sporangia; *b.* capillitium and spores; *c.* spore; (Antigua).

*Hab.* On dead leaves.—Antigua (B.M. 1940).

46. *P. sinuosum* Weinm. ex Fr. Syst. Myc., iii. 145 (1829). Plasmodium white. Sporangia sessile, scattered, elongated, laterally compressed, sinuous or branched, equal in breadth from the base to the flattened upper ridge, which at length splits longitudinally, or sometimes pulvinate and bursting irregularly, white, grey, or yellowish; sporangium-wall double, the outer layer with copious deposits of lime, smooth or reticulated, the inner wrinkled and colourless, showing as a pale membrane along the line of dehiscence, adhering to the outer layer below. Capillitium consisting of numerous white, often branching lime-knots, varying in shape and size, connected by rather short hyaline threads. Spores violet-brown, spinulose, 8 to  $10\mu$  diam.—Rost. Mon., p. 112; Mass. Mon., 305; Macbr. N. Am. Slime-Moulds, 28. *Reticularia sinuosa* Bull. Champ., 94, t. 446, fig. 3 (1791). *Physarum bivalve* Pers. in Usteri Ann. Bot., xv. 5 (1795); Lister Mycetozoa, 57 (1894). *Angioridium sinuosum* Grev. Scot. Crypt. Fl., t. 310 (1828). *Diderma valvatum* Fr. Syst. Myc., iii. 109 (1829). *Carcerina valvata* Fr. Summ. Veg. Scand., 451 (1849).

Pl. 49.—*a.* sporangia (Essex); *b.* capillitium and spores, with fragment of sporangium-wall; *c.* spore.

The characters of this abundant and widely distributed species are retained on the whole with great constancy. It is closely allied to both *P. bitectum* and *P. bogoriense*, differing from the former in having the inner sporangium-wall wrinkled and colourless, in the smaller lime-knots, and in the uniformly spinulose spores, and from the latter species in the dehiscence of the sporangia along the upper ridge only, and in the larger darker spores.

*Hab.* On dead leaves and twigs.—Near Bristol (B.M. 116); Essex (B.M. 1249); Bedfordshire (B.M. 1248); France (K. 28); Germany (B.M. 510); Finland (B.M. 450); Bohemia (B.M. 446); Italy (K. 1345); Portugal (B.M. 2289); Ceylon (B.M. 451); Java (Herb. Penzig); Japan (B.M. 1993); Iowa (B.M. 811); London, Canada (B.M. 1797); South Carolina (B.M. 932); Colorado (B.M. 2290); Chili (Paris Herb.).

47. *P. bogoriense* Racib. in Hedw., xxxvii. 52 (1898). Plasmodium? Sporangia scattered or gregarious, sessile on a narrow base, ovoid and somewhat angular, or forming flexuose plasmodiocarps, varying in colour, reddish-brown buff, yellow or nearly white; outer sporangium-wall smooth, white on the inner side, densely charged with white lime-granules; this layer is usually areolated with pale lines of dehiscence and at length separates in reflexed lobes from the more persistent membranous inner wall. Capillitium consisting of numerous large white smooth-walled rounded and branching lime-knots connected by slender hyaline threads. Spores pale violet-brown, nearly smooth,  $8\ \mu$  diam.—Petch in Ann. Perad., 338. *Diderma pallidum* Berk. & Curt. in Grev., ii. 52 (1873) undescribed. *Physarum pallidum* Lister in Journ. Bot., xxxvi. 117 (1898); Sturgis in Colorado Coll. Publ., Sci. Ser., xii. 20.

Pl. 50.—*a.* sporangia (Antigua); *b.* capillitium and spores, with fragment of double sporangium-wall; *c.* spore.

Closely allied to *P. sinuosum*, q.v.

*Hab.* On dead leaves.—Portugal (B.M. 2291); Cameroons, West Africa (B.M. 2292); Ceylon (Peradeniya Herb.); Java (B.M. 2294); Brisbane (B.M. 535); South Carolina (B.M. 849); Colorado (B.M. 2293); Antigua (B.M. 1653); Brazil (B.M. 2295).

48. *P. bitectum* Lister. Plasmodium white. Sporangia scattered, sessile, and either subglobose or obovoid, 0.6 to 0.8 mm. diam., or forming curved and flexuose plasmodiocarps 2 to 6 mm. long, rounded, or laterally compressed, smooth, white or buff; sporangium-wall double, the outer wall densely charged with white lime-granules, free and deciduous above, recurved and persistent below; inner wall smooth, membranous, pale purplish, more persistent. Capillitium a network of hyaline threads, with numerous variously shaped large smooth-walled white lime-knots. Spores 10 to  $12\ \mu$  diam., purplish-brown, spinulose, with a paler and smoother area of dehiscence. *P. Diderma* Lister (*non* Rost.) in Journ. Bot., xxix. 260 (1891), & Mycetozoa, 57; Sturgis l.c.

Pl. 51.—*a.* sporangia (Bedfordshire); *b.* capillitium and spores, with fragment of double sporangium-wall; *c.* spore.

This abundant species is allied to *P. sinuosum*, from which it differs in having a smooth purplish inner sporangium-wall and rougher spores smoother and paler on one side. In the first edition of the present



work this species was referred to *P. Diderma* Rost. ; a subsequent more complete translation of Rostafinski's description shows *P. Diderma* to have had crowded globose sporangia, characters inapplicable to the present species, for which therefore a new name, *P. bitectum*, is here adopted. In the absence of the type from Warsaw, the position of *P. Diderma* remains uncertain, but the description applies fairly to *P. didermoides* var. *lividum*.

*Hab.* On dead leaves, twigs, etc.—Wanstead, Essex (B.M. 1250); Norfolk (B.M. 2296); Flitwick, Beds (B.M. 1251); Germany (B.M. 512); S. France (B.M. 2297); Portugal (B.M. 2298); Washington State (B.M. 2299); Colorado (B.M. 2301); California (B.M. 2300); Venezuela (B.M. 2302).

49. *P. testaceum* Sturgis in Colorado Coll. Publ., Sci. Ser., xii. 18 (1907). Plasmodium ? Sporangia sessile, white, subglobose, clustered and polygonal from mutual pressure, 0.7 mm. diam. ; outer sporangium-wall white, eggshell-like, separating from the membranous colourless inner wall. Capillitium consisting of numerous large and small angular branching white lime-knots connected by short hyaline threads. Spores purplish-brown or greyish-purple, spinulose, distinctly darker and more spinulose on one side, 8 to 10  $\mu$  diam.—*P. didermoides* var. *lividum* Lister in Journ. Bot., xxxvi. 162 (1898), in part.

Pl. 54.—*a.* sporangia (Colorado); *b.* capillitium and spores; *c.* spore.

This species is closely allied to *P. didermoides* var. *lividum*, from which it differs in the double sporangium-wall and the large branching lime-knots ; it has hitherto been recorded only from the United States, where it appears to be widely distributed and not infrequent.

*Hab.* On dead wood—Maine (B.M. 1595); Vermont (B.M. 2303); Massachusetts (B.M. 2305); Ohio (B.M. 2304); Colorado (B.M. 2058).

50. *P. contextum* Pers. Syn., 168 (1801). Plasmodium yellow. Sporangia sessile, subglobose, ovoid, erect, 0.4 to 0.6 mm. diam., or reniform and elongated on a broad base, crowded, often angled by mutual pressure, rounded or flattened above, smooth, yellowish-white or ochraceous ; sporangium-wall double, the outer layer cartilaginous, usually with dense deposits of lime, often breaking away in the upper part from the thin inner layer. Columella none. Capillitium with scanty hyaline threads and numerous large irregularly branching white lime-knots. Spores dark violet-brown, spinulose, 10 to 13  $\mu$  diam.—Rost. Mon., p. 109 ; Macbr. N. Am. Slime-Moulds, 31. *Diderma contextum* Pers. Obs. Myc., i. 89 (1796). *D. ochroleucum* Berk. & Curt. in Grev., ii. 52 (1873). *D. flavidum* Peek in Rep. N.Y. State Mus., xxviii. 54 (1879). *Physarum conglomeratum* Mass. Mon., 304 (1892). *Lycoperdon luteum* Jacq. Misc., 138, t. 8 (1778) ? *Leocarpus contextus* Fr. Summ. Veg. Scand., 450 (1849).

Pl. 55.—*a.* sporangia (Surrey); *b.* capillitium and spores, with fragment of sporangium-wall; *c.* spore.

The present species is closely allied to *P. conglomeratum*, from which it differs in the larger rougher spores and in the structure of the sporangium-wall. The type of *Diderma ochroleucum* Berk. & Curt. from Pennsylvania (K. 1533) is typical *P. contextum*.

*Hab.* On dead leaves and twigs.—Near Lyme Regis (B.M. 1255); near Birmingham (B.M. 1254); near Paris (B.M. 2307); Germany (B.M. 418); Sweden (B.M. 2308); Austria (B.M. 2306); Tasmania (B.M. 2309); Iowa (B.M. 808); Wisconsin (B.M. 1876); Philadelphia (B.M. 2310); Colorado (B.M. 2311).

51. *P. conglomeratum* Rost. Mon., p. 108, figs. 73, 79, 90 (1875). Plasmodium? Sporangia subglobose, sessile on a broad base, densely aggregated on one plane, angled by mutual pressure, 0.3 to 0.5 mm. broad, yellow or buffish-white, mottled with paler shades; sporangium-wall double, the inner layer of the convex upper wall having translucent, pale yellow curved thickened areas, with a vitreous fracture; the outer layer thick, with deposits of easily crumbling yellow lime-granules. Capillitium consisting of delicate branching hyaline threads, with numerous white or yellowish branching often confluent lime-knots. Spores pale violet-brown, almost smooth, 8 to 10  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 31. *Spumaria minuta* Schum. Enum. Pl. Saell., ii. 196 (1803)? *S. granulata* Schum. l.c.? *Diderma conglomeratum* Fr. Syst. Myc., iii. 111 (1829)? *D. minutum* Fr. l.c.? *D. granulatum* Fr. l.c., 110? *D. flavum* Weinm. Hymen. & Gasterom. 593 (1836)? *D. rugulosum* Weinm. l.c., 594? *Leocarpus granulatus* Fr. Summ. Veg. Scand., 451 (1849)? *L. minutus* Fr. l.c., 450? *Carcerina conglomerata* Fr. l.c., 451? *Physarum Rostafinski* Mass. Mon., 301 (1892).

Pl. 56.—*a.* sporangia (Germany); *b.* capillitium and spores, with fragment of sporangium-wall; *c.* spore.

This species and the preceding are distinguished by differences in the structure of the sporangium-wall and spores,—microscopic characters that the earlier authors were unable to detect; the synonymy quoted above is therefore uncertain, and may refer in part to *P. contextum*. The vitreous structure of the inner wall of the upper part of the sporangium is constant in all the specimens of the present species that we have examined. Fries distinguished *Diderma conglomeratum* from *D. contextum* chiefly by the difference of the capillitium; he describes the presence of a columella in both species, but speaks of the deposits of lime as being more largely developed in *D. conglomeratum*. This is an uncertain character, and varies in different gatherings. Rostafinski was the first to detect the main specific difference, and pointed out that in *Physarum contextum* the spores are rough and measure 10 to 13  $\mu$ , while in *P. conglomeratum* they are nearly smooth and measure 8 to 9  $\mu$  diam. He follows Fries in referring to a columella in *P. conglomeratum*, but adds that it is free and not always evident, and he describes *P. contextum* as being usually without a columella. The specimen K. 1277 marked *Diderma conglomeratum* by Fries, gathered in West Sweden, and taken by Mr. Massee as his type of

*P. conglomeratum* (l.c. 304), is typical *P. contextum*; the name *P. Rostafinskii* Mass., which is given to supersede *P. conglomeratum* Rost. is therefore unnecessary.

*Hab.* On dead leaves and twigs.—Darenth, Kent (B.M. 417); Hutton, Yorks (B.M. 2312); Lyme Regis (B.M. 2313); Germany (B.M. 415); Sikkim, India (B.M. 416); Philadelphia (B.M. 2314).

52. **P. Serpula** Morgan Myx. Miami Valley, 101 (1896). Plasmodium? Sporangia sessile, subglobose or forming long straight or flexuose, simple, branched or ring-shaped plasmodiocarps, 0.3 mm. diam., yellow or ochraceous; sporangium-wall membranous, with dense evenly distributed deposits of yellow lime-granules. Capillitium consisting of numerous angular and branching pale yellow lime-knots, connected by short and scanty hyaline threads. Spores purplish-brown, spinulose, with a paler and smoother area of dehiscence, 10 to 12  $\mu$  diam.—Lister in Journ. Bot., xxxvi. 116 (1898); Macbr. N. Am. Slime-Moulds, 29. *P. gyrosum* Mass. Mon., 307 (1892), in part. *Badhamia decipiens* Lister Mycetozoa, 32 (1894), in part.

Pl. 57.—*a.* plasmodiocarp (Philadelphia); *b.* capillitium and spores, with fragment of sporangium-wall; *c.* spore.

Various attempts were made to unite this well-marked form with previously known species, until the late A. P. Morgan established its position by publishing it as *Physarum Serpula*. In Schweinitz's herbarium at Philadelphia it was named *P. reticulatum* Alb. & Schw., (syn. *Cienkowskia reticulata* Rost.); it was distributed as *P. gyrosum* Rost. by Ellis (N. Am. Fungi, no. 1396); and in the first edition of the present work it was included under a nearly related species, *Badhamia decipiens* Berk., from which it differs in the paler lime-knots being connected by hyaline threads, and in the spores being distinctly paler and smoother on one side.

*Hab.* On dead leaves.—Shawangunk Mountains, New York (B.M. 1181); Philadelphia (B.M. 1870); Ohio (B.M. 1180).

53. **P. aeneum** R. E. Fries in Arkiv Bot., i. 62 (1903). Plasmodium? Sporangia sessile, subglobose, or forming straight or curved, simple branching or net-like plasmodiocarps, 0.3 to 0.4 mm. diam., pinkish-brown or bronze-colour, glossy; outer sporangium-wall somewhat cartilaginous, brown, brittle, with deposits of lime-granules, separating and folding back above from the shining membranous inner wall. Capillitium a network of hyaline threads with numerous rather small round or angular dark or pale brown lime-knots, which sometimes unite to form a pseudo-columella. Spores pale brownish-violet, nearly smooth, 6 to 8  $\mu$  diam.—*P. murinum* var. *aeneum* Lister in Journ. Bot., xxxvi. 117, t. 385, fig. 4 (1898).

Pl. 58.—*a.* sporangia (Bolivia); *b.* capillitium and spores, with fragment of sporangium-wall; *c.* spore.

This species was first discovered by the Rev. W. Cran in the island of Dominica in 1897; in July, 1902, it was collected in Bolivia by Dr R. E. Fries, who established its right to specific rank; since then large gatherings have been made in the island of Santa Cruz, West Indies, by Prof. C. Raunkiaer. In the Dominica specimen the lime-knots are more angular than in those from Bolivia and Santa Cruz, but in other respects the gatherings are very similar.

*Hab.* On dead palm leaves, twigs, etc.—Dominica (B.M. 1643); Santa Cruz, West Indies (B.M. 2316); near Tarija, Bolivia (B.M. 2315).

54. *P. rubiginosum* Fries Symb. Cast., 21 (1817). Plasmodium orange-red (*vide* Schroeter). Sporangia subglobose, 0.5 to 1 mm. diam., sessile, gregarious or crowded, smooth or rugulose, scarlet, reddish- or olive-brown; sporangium-wall membranous, with dense included clusters of orange lime-granules. Columella none. Capillitium an abundant network of hyaline threads with frequent triangular membranous expansions at the axils of the branches; lime-knots large, angular, branching, orange-red or red-brown. Spores pale violet-brown, spinulose, 8 to 11  $\mu$  diam.—Rost. Mon., p. 104; Blytt in Bidr. Norg., Sop., iii. 4; Schroeter in Cohn Krypt. Fl. Schles., iii., pt. 1, 129; Mass. Mon., 302. *P. fulvum* Fr. Syst. Myc., iii. 143 (1829).

Pl. 59.—*a.* sporangia (Brandenburg); *b.* sporangia (New York); *c.* capillitium and spores, with fragment of sporangium-wall; *d.* spore.

Closely allied to *P. auriscalpium* from which it differs in the redder colour and sessile habit of the sporangia and in the more abundant hyaline network of the capillitium. A gathering from Philadelphia sent by Mr. Wingate to Mr. Massee under the name of *Lecocarpus squamulosus* has glossy red-brown sporangia and dark red-brown capillitium; another from Gaddonfield, New York, collected by Dr. Sturgis, has similar capillitium and orange-red sporangia fading where exposed to strong light to a dull ochraceous colour; in all other respects these gatherings agree with the typical form of *P. rubiginosum*.

*Hab.* On dead wood and moss.—Brandenburg (B.M. 2317); Norway (B.M. 2318); Philadelphia (B.M. 2319).

55. *P. lateritium* Morgan Myx. Miami Valley, 95 (1896). Plasmodium? Sporangia subglobose, 0.3 to 0.7 mm. diam., sessile, or forming simple branched or net-like plasmodiocarps, terete or laterally compressed, gregarious, more rarely clustered, orange, brick-red, rosy-red, or red-brown, somewhat rugose, rupturing irregularly; sporangium-wall membranous, colourless above, yellow at the base, with included clusters of red or orange lime-granules. Columella none. Capillitium a network of slender colourless or pale yellow threads, with rounded lime-knots varying in shape and size, the knots orange, or showing red centres surrounded by yellowish round lime-granules. Spores pale brownish-violet, almost smooth, 6 to 9  $\mu$  diam.—Macbride N. Am. Slime Moulds, 33 (1899). *Didymium lateritium*

Berk. & Rav. in Grev., ii. 65 (1873). *D. croceoflavum* Berk. & Br. in Journ. Linn. Soc., xiv. 84 (1873). *Physarum Braunianum* de Bary, Rost. Mon., p. 105 (1875). *P. Ditmari*  $\gamma$  *lateritium* Rost. Mon., App. p. 9 (1876). *Physarum Ditmari*  $\beta$  *croceoflavum* Rost. l.c., p. 9. *P. inaequale* Peck in Rep. N. York Mus. Nat. Hist., xxxi. 40 (1879). *P. chrysotrichum* Mass. Mon., 300 (1892), in part. *P. fulgens* Pat. in Bull. Soc. Myc. Fr., viii. 122 (1892)?

Pl. 60.—*a.* sporangia (South Carolina); *b.* sporangia (Philadelphia); *c.* capillitium and spores, with fragment of sporangium-wall; *d.* spore.

Pl. 61.—*d.* sporangia of type of *P. Braunianum* de Bary (Berlin).

This species is variable in the colour and shape of the sporangia; the bright rosy form somewhat resembles *P. rubiginosum*, but is distinguished by the paler more rounded lime-knots; the orange form appears to be nearly allied to *P. virescens*, but differs in the sporangia being more scattered and having a tendency to form long slender plasmodiocarps, which are often pale yellow or grey in the lower part. The specimen from Carolina marked in Berkeley's herbarium *Didymium terrigenum* Berk. & Curt. (B.M. 575) is in poor condition but seems to be the present species rather than *P. virescens*, with which it was placed in the first edition of this work. Dr. Jahn has recently found in the herbarium of the Berlin Museum the type of *P. Braunianum* de Bary, collected in June, 1852, on moss in Grünwald near Berlin, by A. Braun. The minute sporangia are globose, clustered or scattered, 0.2 to 0.3 mm. diam., purplish-brown and either without lime deposits, or spotted and veined with clusters of brick-red lime-granules; the scanty capillitium consists of slender hyaline threads and yellow or nearly white lime-knots; the spores are violet-grey, 9  $\mu$  diam.; the specimen is not perfectly developed, and it is a question whether it should be placed with *P. virescens* or *P. lateritium* but the brick-red colour of the sporangia favours the latter position.

*Hab.* On dead leaves, wood, and twigs.—Near Berlin (B.M. 2322); Ceylon (B.M. 414); Java (B.M. 2320); Georgia (B.M. 899); Ohio (B.M. 1263); Adirondack Mountains, New York (B.M. 1264); Antigua (B.M. 1655); Brazil (B.M. 2321).

56. *P. virescens* Ditm. in Sturm Deutsch. Fl., Pilze, i. 123, t. lxi (1817). Plasmodium lemon-yellow. Sporangia subglobose or irregularly ovoid, 0.2 to 0.4 mm. diam., sessile, heaped or gregarious, rugose or nearly smooth, pale yellowish-green, orange-yellow, or purple-brown from the absence of lime; sporangium-wall membranous, with dense included clusters of minute yellow lime-granules, rarely without lime. Columella none. Capillitium a network of hyaline threads with fusiform roundish or irregular yellow lime-knots. Spores almost smooth, pale violet-brown, 7 to 10  $\mu$  diam.—Rost. Mon., p. 103; Mass. Mon., 277; Macbr. N. Am. Slime-Moulds, 33. *P. thejoteum* Fr. Symb. Gast., 21 (1818); Macbr. l.c., 36. *P. Ditmari* Rost. Mon., App. p. 8 (1876). *Didymium nectriaeforme* Berk. & Curt. in Grev., ii. 66 (1873). *D. sinapinum* Cooke Myx. Brit., 33 (1877).

Var. 1.—**obscurum** Lister : sporangia sessile, 0.4 to 0.8 mm. diam., subglobose or forming plasmodiocarps, gregarious or crowded, greenish-grey, often spotted with pale yellow or olive-brown, somewhat glossy; sporangium-wall membranous, colourless above, yellow at the base, either without lime, or with widely scattered clusters of whitish lime-granules : lime-knots bright yellow : spores 6 to 8  $\mu$  diam.

Var. 2.—**nitens** Lister : sporangia subglobose, 0.5 to 0.8 mm. diam., sessile, gregarious, not clustered, bright yellow : spores 7 to 9  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 34. *P. luteolum* Peck in Rep. N. York Mus. Nat. Hist., xxx. 50 (1878) ? ; see Sturgis in Trans. Conn. Acad., x. 470 (1900). *P. auriscalpium* Macbr. (*non* Cooke) in Bull. Nat. Hist. Iowa, ii. 158 (1893).

Pl. 61.—*a.* sporangia (Essex); *b.* capillitium and spores, with fragment of sporangium-wall, showing three calcareous discs; *c.* spore; *e.* sporangia of var. *obscurum* (Devon).

Pl. 62.—var. *nitens*; *a.* sporangia (Maine); *b.* capillitium and spores, with fragment of sporangium-wall; *c.* spore.

Glycerine mountings of the typical form show, dispersed in the sporangium-wall, flattened disc-shaped crystalline bodies with a radiating structure, measuring 10 to 20  $\mu$  diameter; these are also found in the sporangium-wall of *P. psittacinum*, *P. dictyospermum*, and *Craterium leucocephalum*; they do not appear to be present in vars. *obscurum* and *nitens*. Through the courtesy of Professor Macbride we have received a specimen of the form he has published as *P. theioteum* Fr. (B.M. 2329); the small golden-yellow sporangia are on dead wood, and crowded, not heaped, on a membranous hypothallus; the sporangium-walls with their characteristic "discs," the capillitium and spores are those of typical *P. virescens*. The var. *obscurum* has been found four times in England, and has also been recorded from Scotland, Hungary, and the Adirondack Mts., New York; the capillitium and spores are similar to the typical form, but in external appearance it differs markedly in the larger and often scattered sporangia with glossy and almost limeless walls. The var. *nitens* is a handsome form, having rather larger sporangia than the type, with which it is connected by gatherings intermediate in character. Dr. Sturgis has examined the scanty and injured remains of the type of *P. luteolum* Peck in the New York State Museum at Albany; he regards it as being probably *P. virescens* var. *nitens*, and considers that Peck's name should be discarded (see Sturgis l.c.).

*Hab.* On dead leaves, moss, etc., more rarely on wood.—Epping Forest, Essex (B.M. 1256); Dorset (B.M. 2323); Norfolk (B.M. 2324); France (Paris Herb.); Germany (B.M. 413); Dorfalden (B.M. 861); Bohemia (B.M. 2326); Switzerland (B.M. 2325); Massachusetts (B.M. 1258); Philadelphia (B.M. 1905); var. *obscurum*—Devon (B.M. 1257); Hungary (K. 1529); Adirondack Mountains (B.M. 1259); var. *nitens*—New Hampshire (B.M. 1260); Maine (B.M. 1261); Iowa (B.M. 1011).

57. **P. alpinum** G. Lister in Journ. Bot., xlviii. 73 (1910). Plasmodium? Sporangia clustered or scattered, sessile, 1 to 1.3 mm. diam., or forming curved or straight

plasmodiocarps 2 to 30 mm. long, pale yellow or ochraceous, scaly or smooth; outer sporangium-wall densely charged with calcareous deposits, separating from the membranous inner wall. Capillitium with abundant and rather large simple or branching yellow lime-knots connected by a scanty network of firm hyaline threads with broad membranous expansions. Spores purple-brown, closely and minutely warted, 9 to 14  $\mu$  diam.—*P. virescens* Ditm. var. *alpina* Lister in Journ. Bot., xlv. 216 (1908).

Pl. 62.—*d.* sporangia (California); *e.* capillitium and spores, with fragment of sporangium-wall; *f.* spore.

This species was first gathered in the Blue Cañon, California, by Dr. Harkness (B.M. 2327), and was named in Phillips' herbarium *Badhamia inaurata* (see Mycetozoa, ed. 1, p. 61). It has since been found near Arolla, Switzerland, 8,000 feet altitude, and M. Ch. Meylan has repeatedly gathered it in the Jura Mountains, near Ste. Croix, at an elevation of from 3,000 to 4,000 feet, where it appeared on turf on the mountain-side in the company of *P. vernum* after the thawing of the winter snows. In general structure and in the colour of the spores the present species is curiously like the alpine form of *P. vernum*, though differing entirely in the yellow colour of the sporangia and lime-knots. It appears to be related to *P. contextum* from which it is distinguished by the yellow lime-knots and by the sporangia being larger, more scattered, and usually forming plasmodiocarps.

*Hab.* On leaves, grass and sticks in alpine regions.—Ste. Croix, Jura Mountains (B.M. 2328); California (B.M. 2327).

The following species of *Physarum* are rejected from their descriptions being too brief to be serviceable:—

<i>P. atrum</i> Fr.	<i>P. flavovirens</i> Alb. & Schw.
<i>P. chlorinum</i> Cooke.	<i>P. hypnophilum</i> Fr.
<i>P. connatum</i> Schum.	<i>P. luteovalve</i> Schwein.
<i>P. corrugatum</i> Link.	<i>P. piceum</i> Fr.
<i>P. crustiforme</i> Speg.	<i>P. polyaedron</i> Schwein.
<i>P. elegans</i> Schwein.	<i>P. purpurascens</i> Link.
<i>P. elongatum</i> Link.	<i>P. stipitatum</i> Chev.
<i>P. fimetarium</i> Schum.	<i>P. villosum</i> Schum.

The description of *Tilmadoche cavipes* Berk. from the Andaman Isles (see Grev., xi. 39)—with brick-red sporangia, cottony white stalks, and yellow spores—suggests that this species should be excluded from the Mycetozoa.

Genus 4.—**FULIGO** Haller Hist. Stirp. Helv., iii. 110 (1768). Sporangia elongated, branching and interwoven, combined to form a pulvinate aethalium; the outer layer of sporangia often barren and forming a cortex charged with deposits of lime-granules and without spores; capillitium with few or many lime-knots.

KEY TO THE SPECIES OF *FULIGO*.

- Aethalium and lime-knots yellow, rarely reddish or white ;  
 spores 7 to 9  $\mu$ . 1. *F. septica*  
 Aethalium yellowish-grey ; lime-knots numerous, orange-  
 yellow ; spores 10 to 11  $\mu$ . 2. *F. muscorum*  
 Aethalium and lime-knots pure white, the latter large ; spores  
 10 to 14  $\mu$ , often ellipsoid. 3. *F. cinerea*

1. *F. septica* Gmelin Syst. Nat., 1466 (1791). Plasmodium yellow, rarely white. Aethalia pulvinate, varying much in size, from 2 mm. to 20 cm. broad, yellow, pinkish or dull white or reddish-brown. The sporangia constituting the aethalium are intricately coiled and anastomosing, 0.2 to 0.25 mm. broad, with air spaces in the intervals which permeate the mass ; the cortex is sometimes wanting, when the surface is grey and marked with brain-like convolutions ; sporangium-walls within the aethalium membranous, very fragile, colourless, with scattered deposits of lime-granules. Columella none. Capillitium scanty or abundant, consisting of a loose network of slender hyaline threads more or less expanded at the axils, with fusiform or branching yellow or whitish lime-knots, varying much in size. Spores violet, almost smooth, 6 to 8  $\mu$ , rarely 8 to 10  $\mu$  diam.—Blytt in Bidr. Norg., Sop. iii. 5 (1892). *Mucor septicus* Linn. Sp. Pl., ed. 2, 1656 (1763). *M. primus* (ovatus) Schaeff. Fung. Bav., 132, fig. 192 (1763). *M. Mucilago* Scop. Fl. Carn., ed. 2, ii. 492 (1772). *Reticularia lutca* Bull. Champ., 87, t. 380, fig. 1 (1791). *R. hortensis* Bull. l.c., 86, t. 424, fig. 2. *R. carnosa* Bull. l.c., 85, t. 424, fig. 1. ? *Fuligo flava* Pers. in Roemer N. Mag. Bot., i. 88 (1794). *F. rufa* Pers. l.c. *F. vaporaria* Pers. Obs., i. 92. *F. candida* Pers. l.c. *F. laevis* Pers. Syn., 160 (1801). *F. violacea* Pers. l.c. ; Macbr. N. Am. Slime-Moulds, 24. *F. flavescens* Schum. Enum. Pl. Saell., ii. 194 (1803). *F. varians* Somm. Fl. Lapp., 239 (1826) ; Rost. Mon., p. 134 ; Mass. Mon., 430. *F. tatrica* Racib. in Hedw., xxiv. 169 (1885). *F. ovata* Macbr. l.c., 23 (1899). *Aethalium flavum* Link in Mag. Ges. Nat. Fr. Berl., iii. 42 (1809). *A. septicum* Fr. Syst. Myc., iii. 93 (1829). *A. ferricola* Schwein. in Trans. Amer. Phil. Soc., n.s. iv. 261 (1832) ? *Licea Lindheimeri* Berk. in Grev., ii. 68 (1873). \* *Tubulina Lindheimeri* Mass. l.c., 42 (1892). *Physarum cerebrinum* Mass. l.c., 306.

Pl. 74.—*a.* part of a small ecorticate aethalium (Essex) ; *b.* white aethalium (Hants) ; *c.* reddish aethalium (Essex) ; *d.* capillitium and spores from aethalium "*c.*" ; *e.* capillitium and spores from aethalium "*a.*" ; *f.* spore.

\* Through the courtesy of Prof. Macbride we have had the opportunity of examining the specimen described under the name of *Licea Lindheimeri* Berk., by Morgan (Myx. Miami Valley, Macbr. N. Am. Slime-Moulds, 147, t. xii., figs 6, 6a, 6b) ; it is an ascomycetous fungus belonging to the Order *Perisporiacei*, probably a species of *Emericella*.



This conspicuous species has received the popular English name of "Flowers of Tan" from its frequent occurrence in tan-yards on heaps of spent tan. It is perhaps the most abundant and widely distributed of all the Mycetozoa. The colour of the plasmodium is usually bright lemon-yellow, but Dr. Jahn finds in the woods near Berlin a white variety, having the typical small violet spores, maturing from white plasmodium. The aethalia vary much in size, in colour, and in the amount to which the cortex is developed. It is found that if the rising plasmodium is protected by a bell-glass from currents of dry air, the sporangia develop well throughout, there is no cortical layer, and a number of small aethalia may be formed rather than a single large one; when on the other hand the young aethalium is exposed to dry winds or sunlight, the cortex becomes thick. The type of *Physarum cerebrinum* Mass., produced in a hot-house at Kew (K. 195), is a form of *F. septica* with no cortex developed over the convoluted sporangia. In the type specimen of *Licea Lindheimeri* Berk. from Texas (K. 1648) only the basal part of an aethalium remains; it is an orange form of the present species with scanty capillitium and violet spores measuring 5 to 7  $\mu$ .

*Hab.* On dead wood, tan, etc.—Leytonstone, Essex (B.M. 1265); Lyme Regis (B.M. 1266); Highgate (B.M. 155); France (B.M. 459); Germany (B.M. 457); Austria (B.M. 460); Italy (B.M. 461); Finland (B.M. 463); South Africa (K. 232); Ceylon (Peradeniya Herb.); Queensland (B.M. 468); New Zealand (B.M. 2331); Japan (B.M. 1997); Virginia (B.M. 1954); Dominica (B.M. 1745); Antigua (B.M. 1656); Brazil (B.M. 2332).

2. *F. muscorum* Alb. & Schwein. Consp. Fung., 86, t. vii, fig. 1 (1805). Plasmodium apricot-yellow, translucent. Aethalia pulvinate, 2 mm. to 5 cm. in diam., scattered, clustered or somewhat imbricated, nearly smooth, formed of very closely interwoven sporangia, yellowish-grey or grey, seated on an orange hypothallus; cortex scanty or none; sporangium-wall membranous with scattered deposits of orange lime-granules. Capillitium of numerous irregular often branching orange lime-knots connected by rather short hyaline threads. Spores violet-brown, spinulose, 10 to 11  $\mu$  diam.—Macbr., N. Am. Slime-Moulds, 24. *Lignidium griseoflavum* Link in Mag. Ges. Nat. Fr. Berl, iii. 24 (1809). *L. muscicola* Fr. Symb. Gast., 10 (1817). *Reticularia muscorum* Fr. Syst. Myc., iii. 91 (1829). *Physarum gyrosum* Rost. Mon., p. 111 (1875), in part. *Licea ochracea* Peck in Rep. N. York Mus. Nat. Hist., xxviii. 55 (1879). *Fuligo ochracea* Peck l.c., xxxi. 56 (1879); Mass. Mon., 342; Lister Mycetozoa, 67. *F. simulans* Karst. in Bidr. Känn. Finl. Nat., xxxi. 108 (1879).

Pl. 77.—a. aethalium, on moss (Surrey); b. capillitium and spores with fragment of sporangium-wall; c. spore.

This species differs from *F. septica* in the smooth clustered aethalia, in the orange lime-knots connected by short hyaline threads, and in the larger rougher spores. In some seasons the plasmodium is abundant on turf, rushes, etc., on moist moorland, occurring in masses many inches across, and creeping up the adjacent plants to form on the under surface of their stems and leaves numerous rounded aethalia, whose

dingy colour renders them when mature and dry extremely inconspicuous. When protected from currents of air, the sporangia form less compact aethalia, and may in part remain free as simple or branched plasmodiocarps.

*Hab.* On sticks, rushes, bracken, etc., in moist places.—Epping Forest, Essex (B.M. 2333); Beds (B.M. 2334); Surrey (B.M. 2335); North Wales (B.M. 1765); Brandenburg (B.M. 2223); Sweden (Herb. Dr. R. E. Fries); Switzerland (Zürich Herb.); Ceylon (Peradeniya Herb.); Adirondack Mountains, New York (B.M. 1267); Maine (B.M. 2336).

3. *F. cinerea* Morg. Myx. Miami Valley, 105 (1896). Plasmodium white. Aethalia pulvinate, elongate, simple or branched, 4 to 60 mm. long, scattered or gregarious, formed of closely interwoven sporangia, usually enclosed in a smooth white cortex densely charged with lime and continuous with the white hypothallus. Sporangium-walls within the aethalium more or less perfect, membranous, with deposits of white lime-granules. Capillitium consisting of simple or branched hyaline threads, and large white lime-knots that may unite to form a pseudo-columella, or almost *Badhamia*-like. Spores brownish-violet, spinulose, ellipsoid, 13 to 17  $\times$  8 to 12  $\mu$ , or subglobose, 9 to 12  $\mu$  diam.—*Enteridium cinereum* Schwein. in Trans. Amer. Phil. Soc., n.s. iv. 261 (1832). *Physarum ellipsosporum* Rost. Mon., App. p. 10 (1876); Mass. Mon., 310; Macbr., N. Am. Slime-Moulds, 27. *Badhamia coadnata* Rost. Mon., p. 146 (1875); Mass. l.c., 325. *Aethaliopsis stercoriformis* Zopf Pilzthiere, 150, fig. 26 (1884). *Fuligo stercoriformis* Racib. in Hedw., xxvi. 111 (1887); Mass. l.c., 342. *F. ellipsospora* Lister Mycetozaa, 67; Petch in Ann. Perad., iv. 342.

Var. *ecorticata* Lister: aethalia composed of more loosely combined sporangia, irregular in outline, without cortex, white, buff, or pale reddish-brown; spores often globose, 9 to 12  $\mu$  diam.

Pl. 75.—*a.* part of an ecorticate aethalium (Beds); *b.* group of aethalia, on straw; *c.* capillitium and spores; *d.* spore.

The typical form of this widely distributed species has been found in some years in great abundance about heaps of old straw in Bedfordshire, but does not appear to be common in the British Isles. Mr. Petch describes it as being fairly abundant in Ceylon. The var. *ecorticata* occurs both on dead leaves and on wood; it is not infrequent in this country, and has also been obtained from Germany and from both the eastern and western United States; the spores are usually rather paler and smaller than in the typical form, between which and the white variety of *F. septica* it holds an intermediate position. The type of *Badhamia coadnata* Rost. from Cuba in the Strassburg herbarium consists of smooth corticate aethalia of the present species. From the description and illustration of *Aethaliopsis stercoriformis* Zopf there can be no doubt that this also is *Fuligo cinerea*.

*Hab.* On dead leaves, straw, etc.—Beds (B.M. 1761); Italy (B.M. 1786); Ceylon (Peradeniya Herb.); Philippine Islands (B.M. 2040); Japan (B.M. 2339); Iowa (B.M. 810); Ohio (B.M. 1268); var. *ecorticata* —Berks (B.M. 1720); Epping Forest (B.M. 2337); Germany (B.M. 2338); Philadelphia (B.M. 2340); Kansas (B.M. 2341).

Genus 5.—**ERIONEMA** Penzig in Myx. Buit., 36 (1898). Sporangia forming long cylindrical simple or branched plasmodiocarps; capillitium a close elastic network of slender colourless threads with few small lime-knots.

1. **E. aureum** Penz. l.c., 37. Plasmodium colourless or yellowish. Sporangia long, cylindrical, 0.2 to 0.3 mm. diam., lemon-yellow, or greyish-olive spotted and banded with yellow, either clustered and drooping on slender branched stalks, or sessile and forming straight or curved branched and often interlacing plasmodiocarps; sporangium-wall a pale yellow membrane, with more or less abundant deposits of yellow lime-granules. Stalks yellow, filiform, merging into the anastomosing strands of the hypothallus. Capillitium a close persistent network of slender colourless threads with few small fusiform yellow lime-knots; at maturity the sporangium-wall breaks away in flakes, and the cylindrical network of capillitium expands longitudinally to several times its original length. Spores pale brownish-violet, nearly smooth, 6 to 7  $\mu$  diam.—Lister in Journ. Bot., xlii. 98, tab. 458; Petch in Ann. Perad., iv. 341.

Pl. 73.—*a.* sporangia (Java); *b.* capillitium and spores; *c.* spore.

The present species is distinguished from *Fuligo septica*, some ecorticate forms of which it resembles, by the remarkable elastic capillitium. *Erionema aureum* was first found by Professor Penzig in the botanic gardens of Buitenzorg, in November, 1896; since then Professor Ernst has again met with it in the island of Java; Mr. Kusano has found it in the botanic gardens, Tokyo, Japan, and Mr. Petch has twice gathered it in Ceylon.

*Hab.* On dead twigs, leaves, etc.—Java (B.M. 1710); Japan (B.M. 2342).

Genus 6.—**TRICHAMPHORA** Junghuhn Fl. Crypt. Jav., 12 (1838). Sporangia discoid or saucer-shaped, stalked; stalk red-brown; sporangium-wall membranous, with evenly distributed deposits of lime-granules; capillitium consisting of colourless branching threads with many or few lime-knots, or of membranous tubes filled with lime throughout, or without lime.

*Trichamphora* is somewhat artificially separated from the unwieldy genus *Physarum*, to which it is very closely allied, on account of the remarkable saucer-like shape of the sporangia, and from the capillitium being frequently without any deposits of lime.

1. **T. pezizoidea** Jungh. l.c. Plasmodium greyish-white. Total height 1 to 2.5 mm. Sporangia gregarious, stalked, discoid or saucer-shaped, erect or somewhat inclined, 0.8 to 1.3 mm. broad, 0.2 to 0.3 mm. thick, greyish-white; sporangium-wall membranous, with thin included deposits of lime equally distributed, breaking up at maturity into areolae and remaining attached to the capillitium after the dispersion of the spores. Stalk subulate, longitudinally striate, reddish-brown, translucent. Capillitium very variable, consisting either of branching anastomosing colourless threads with broad expansions at the axils and at the attachment to the sporangium-wall, and either with or without fusiform lime-knots, or *Badhamia*-like and formed of membranous tubes filled with lime throughout. Spores dark or pale purplish-brown, spinose, spinulose or nearly smooth, 9 to 17  $\mu$  diam.—Lister in Journ. Bot., xxxix. 85, & xlii. 132. *Physarum macrocarpum* Fuckel Symb. Myc., 343 (1869) (*non* Cesati). *P. Muelleri* Berk. MS. in herb. *P. pezizoideum* Pav. & Lag. in Bull. Soc. Myc. Fr., xix. fasc. ii. 7 (1903). *Trichamphora Fuckeliana* Rost. in Fuckel l.c., Nachtr. 2, 71 (1873); Rost. Mon., p. 138. *Didymium zeylanicum* Berk. & Br. in Hook. Journ. Bot., vi. 230 (1854). *D. pezizoideum* Mass. Mon., 239 (1892). *D. australe* Mass. in Grev., xvii. 7 (1888). *D. parasiticum* Sacc. & Syd. Syll. Fung., xiv. 836 (1899). *Chondrioderma pezizoides* Rost. Mon., p. 424 (1875). *C. zeylanicum* Rost. Mon., App. p. 15 (1876). *C. Muelleri* Rost. l.c. *C. Berkeleyanum* Rost. l.c., p. 16. *Badhamia Fuckeliana* Rost. l.c., p. 2; Mass. l.c., 321.

Pl. 72.—a. sporangia (Brisbane); b. capillitium and spores with fragment of sporangium-wall; c. spore (Brisbane); d. spore (E. Africa).

This species often forms large plasmodia, resulting in many hundred sporangia. It displays in its various forms all the types of capillitium characteristic of *Badhamia*, *Physarum* and, to some extent, of *Didymium*, and has been published under different names in each of these genera. A large number of gatherings have now been obtained from many parts of the world, having the characteristic saucer-shaped sporangia\* and translucent red-brown stalks, but exhibiting great variety both in the amount of lime in the capillitium, and in the size, colour and roughness of the spores. Junghuhn's type from Java is the form with no lime in the slender threads of the capillitium, as also are the types of *Physarum Muelleri* Berk. from Queensland, *Chondrioderma Berkeleyanum* Rost. from Tahiti, *Didymium zeylanicum* Berk. & Br. from Ceylon, and *D. australe* Mass. from Brisbane. In the type of *Badhamia Fuckeliana* Rost., from Germany, the capillitium consists of membranous tubes free from lime-granules. A specimen from Togo, German East Africa (B.M. 2343), collected by Staudt in 1897 has *Badhamia*-like capillitium and dark echinulate spores 15  $\mu$  diam. A large gathering made by Mr. Petch in the Peradeniya Gardens,

\* Discoid sporangia are met with also in *Badhamia orbiculata*, *Physarum javanicum*, *P. viride* var. *rigidum* and *P. polycephalum* var. *obrusseum*.

Ceylon (B.M. 2344), has rather broad and nearly simple capillitium threads with long fusiform lime-knots; the spores are dark, spinulose, and measure  $17\ \mu$  diam. The specimen B.M. 2052 from the Philippine Islands has slender branching capillitium, small lime-knots, and violet-brown, minutely warted spores measuring  $9\ \mu$ . The present species appears to be nearly allied to *Physarum javanicum*, but is distinguished by the more saucer-shaped sporangia, the red colour of the stalks and the darker usually larger spores.

*Hab.* On dead leaves, wood, *Auricularia*, etc.—Montpellier, France (B.M. 2345); Germany (B.M. 403); Sweden (B.M. 1317); Togo, East Africa (B.M. 2343); Madagascar (B.M. 1001); Natal (K. 376); Ceylon (B.M. 576); Java (B.M. 2346); Borneo (B.M. 2347); Sumatra (B.M. 1315); Queensland (B.M. 1316); Philippine Islands (B.M. 2036); Tahiti (K. 1207A); Brazil (B.M. 2348).

Genus 7.—**PHYSARELLA** Peck in Bull. Torr. Bot. Club, xi. 61 (1882). Sporangia stalked, shortly cylindrical, perforated from above by a deep umbilicus; capillitium consisting of slender threads with minute fusiform lime-knots, and stout spine-like processes densely charged with lime-granules, springing perpendicularly from the sporangium-wall.

1. **P. oblonga** Morg. Myx. Miami Valley, 79 (1896). Plasmodium rich yellow. Total height about 3 mm. Sporangia gregarious, stalked, shortly cylindrical, inclined, 0.8 mm. long, 0.6 mm. broad, perforated from above by a deep umbilicus, which is continuous with the hollow stem, greenish or reddish-yellow; in abnormal developments sporangia erect, funnel-shaped or irregularly expanded, rarely sessile and forming net-like plasmodiocarps; sporangium-wall a yellow membrane thickened with included deposits of yellow lime-granules and studded with the spine-like processes of the capillitium, at length dehiscing round the cylindrical apex of the sporangium and recurving in stellate lobes from the wall of the umbilicus, which persists to form a hollow orange-yellow columella. Stalk cylindrical, slender, broader at the base, or thick and irregular, striate, red-brown, translucent. Capillitium consisting normally of abundant filiform forking pale yellow threads, with few minute fusiform yellow lime-knots, and yellow or orange spine-like processes 0.2 mm. long,  $20\ \mu$  thick, extending from the outer wall of the sporangium to the walls of the columella, densely charged with granules of lime; in plasmodiocarp forms the capillitium may consist of a network of yellowish threads with large irregular orange lime-knots, and have no spine-like processes. Spores violet-brown, nearly smooth, 6 to  $8\ \mu$  diam.—Macbride N. Am. Slime Moulds, 71. *Trichamphora oblonga* Berk. & Curt. in Grev., ii. 66 (1873). *Physarum rufibasis* Berk. & Br. in Journ. Linn. Soc., xiv. 85 (1873). *P. hians*, Mass. Mon., 296 (1892). *Chondrioderma inflatum* Rost. Mon., p. 425 (1875). *Tilmadoche*

*oblonga* Rost. Mon., App. p. 13 (1876). *T. hians* Rost., l.c., p. 14. *T. minuta* Berl. in Sacc. Syll., vii. 361 (1888). *Physarella mirabilis* Peck in Bull. Torr. Bot. Club, ix. 61 (1882); Lister Mycetozoa, 68; Petch in Ann. Perad., iv. 339.

Pl. 71.—*a*, sporangia (Philadelphia); *b*, capillitium and spores with fragment of sporangium-wall; *c*, capillitium from an irregularly formed sporangium; *d*, spore.

This species when well formed presents a strikingly graceful aspect either in the stage where the sporangia are still unbroken, or when they have expanded in a flower-like manner to expose the orange trumpet-shaped columellae and curious spike-like processes of the capillitium. When development has not been perfect irregular distorted sporangia occur. The type of *Physarum rufibasis* Berk. & Br. from Ceylon has open funnel-shaped sporangia on short stout stalks connected below by an ample hypothallus. This is one of the two specimens quoted by Rostafinski as types of his *Tilmadoche hians*; the other is referred to as follows:—"The specimen seen was gathered by Jan Kickx (father) in Flanders, and marked by him *Craterium minutum* Fr."; it appears to be the only typical example of the present species yet recorded from Europe. A specimen gathered by Mr. W. G. Freeman at Onitcha Olona, Nigeria (B.M. 2349), shows every variety between typical sporangia and net-like plasmodiocarps; the latter have in part the characteristic capillitium, and in part a capillitium consisting of a close network of orange threads with small and large irregular and branching lime-knots.

A remarkable form showing close affinity to the present species has been found by Dr. Torrend on the bark and leaves of *Eucalyptus globulus* in the royal park of Alfieti, Portugal, and has been named by him *Physarella lusitanica* (Fl. Myx., 173, 1909). The sporangia are subglobose or lenticular, and for the most part are deeply umbilicate above; in some cases the umbilicus is shallow, in others it is so deep as to be continuous with the stalk; the capillitium consists of a close network of orange threads with few or many large irregular lime-knots, while in one sporangium it was almost *Badhamia*-like. If this form should prove constant it may well deserve specific rank.

*Hab.* On dead wood.—South Nigeria (B.M. 2349); Ceylon (B.M. 2350); Java (K. 1312); Borneo (B.M. slide); Philippine Islands (B.M. 2055); Kansas (B.M. 2351); Ohio (B.M. 1260); Philadelphia (B.M. 1269); Antigua (B.M. 1658); Brazil (B.M. 2352).

Genus 8. — **CIENKOWSKIA** Rostafinski Versuch, 9 (1873). Sporangia forming net-like plasmodiocarps. Sporangium-wall cartilaginous at the base; capillitium a loose network of rigid threads with many free, curved, sharp-pointed branchlets, connected with flat perforated calcareous plates attached at their margins to the sporangium-wall.

1. *C. reticulata* Rost. l.c. Plasmodium deep orange-red. Sporangia sessile, scattered, forming cylindrical usually branched and net-like plasmodiocarps, 0.5 mm. diam., attached by a narrow basal keel to the substratum, yellow-brown or orange, with pale transverse ridges, blotched with crimson; sporangium-wall orange-yellow, membranous

above, cartilaginous below, marked with the bases of the calcareous plates of the capillitium. Columella none. Capillitium consisting of an elastic network of flexuose rigid yellow threads, with numerous free sharp-pointed unciniate branchlets, and of lime-deposits in the form of flat, perforated, pale yellow plates disposed transversely to the axis of the sporangium and connected by broad or narrow attachments to the sporangium-wall, occasionally with irregular lime-knots intermixed. Spores clear violet-brown, minutely spinulose, 9 to 11  $\mu$  diam.—Rost. Mon., p. 91; Mass. Mon., 337; Macbride N. Am. Slime-Moulds, 80; Petch in Ann. Perad., iv. 341. *Physarum reticulatum* Alb. & Schw. Consp. Fung., 90 (1805). *Diderma reticulatum* Fr. Syst. Myc., iii. 112 (1829).

Pl. 70.—*a.* plasmodiocarp (Leicestershire); *b.* portion of a plasmodiocarp with the wall broken and showing vertical plate-like lime-knots; *c.* capillitium and spores; *d.* spore.

The net-like plasmodiocarps of this species are often very extensive, and may cover an area of several square inches. On maturity the sporangium wall usually breaks away above, and the capillitium expands longitudinally to many times its original length and lies in orange-coloured festoons about the surface of the wood, leaving exposed the glossy crimson bases of the net-like plasmodiocarps. Mr. Petch found this species to be fairly common at Peradeniya, Ceylon, from April to June in 1905, but he met with no specimen in the four succeeding years. He writes that on exposure to sunlight the rich red-brown colour of the sporangia is soon lost, and they become blackish-brown, while the capillitium is bleached almost white.

*Hab.* On dead wood.—Sibbertoft, Leicestershire (K. 1198); France (Edinburgh Herb.); Germany (Strassburg Herb.); Portugal (B.M. 2846); Ceylon (B.M. 2353); Java (K. 1772); Iowa and Colorado (Herb. Dr. W. C. Sturgis).

Genus 9.—**CRATERIUM** Trentepohl in Roth Catal. Bot., i. 224 (1797). Sporangia stalked, either goblet-shaped with a lid of thinner substance, or without a distinct lid and obovoid or sub-globose; sporangium-wall charged with granules of lime, and cartilaginous at least in the lower part. Capillitium consisting of hyaline threads connecting large lime-knots, some of which often combine in the centre of the sporangium to form more or less of a columella. Stalk cartilaginous.

#### KEY TO THE SPECIES OF *CRATERIUM*.

A. Sporangium-wall smooth, glossy; lid distinct :—

Lime-knots white.

1. *C. minutum*

Lime-knots brown.

2. *C. concinnum*

*B.* Sporangium-wall mealy, often rugose; lid less distinct or indefinite :—

Sporangia violet.

3. *C. paraguayense*

Sporangia brown, powdered with white in the upper part.

4. *C. leucocephalum*

Sporangia bright yellow.

5. *C. aureum*

1. *C. minutum* Fries Syst. Myc., iii. 151 (1829). Plasmodium rich yellow. Total height 0·7 to 1·5 mm. Sporangia goblet-shaped, stalked, erect, gregarious, 0·4 to 1·2 mm. high, smooth, pale ochraceous, nut-brown or olive-brown; lid convex or flat, sometimes depressed, white or concolorous with the sporangium; sporangium-wall of two layers, the outer cartilaginous, thickened at the rim below the lid, translucent below and continued into the translucent stalk, the inner layer densely charged with white lime-granules; lime almost absent in the olive-brown form. Stalk cylindrical, plicate, 0·3 to 0·5 mm. long, dark brown, orange-brown or yellowish, rising from a circular hypothallus. Capillitium consisting of delicate colourless or yellow threads connecting numerous large white lime-knots, some of which often combine in the centre to form a pseudo-columella. Spores violet-brown, minutely warted, 8 to 9  $\mu$  diam.—Rost. Mon., p. 120; Macbr. N. Am. Slime-Moulds, 78. *Peziza minuta* Leers Fl. Herborn., 277 (1775). *Craterium pedunculatum* Trentep. in Roth Catal. Bot., i. 224 (1797); Lister Mycetozoa, 70. *C. vulgare* Ditm. in Sturm Deutsch. Fl., Pilze, i. 17, t. 9 (1813); Rost. l.c., p. 118. *C. pyriforme* Ditm. l.c., p. 19, t. 10; Rost. l.c., p. 120. *C. turbinatum* Fr. l.c., 152. *C. Oerstedtii* Rost. l.c., p. 120 (1875). *C. Friesii* Rost. l.c., p. 122. *C. confusum* Mass. Mon., 263 (1892). *Sphaerocarpa operculata* Schum. Enum. Pl. Saell., ii. 220 (1803). *Physarum turbinatum* Schum. l.c., 205.

Pl. 78.—*a. b. c.* sporangia of various shapes (Dorset); *d.* capillitium and spores with a fragment of sporangium-wall; *e.* spore.

Observations on the development of sporangia from extensive plasmodia in leaf-heaps and in cultivations show that the varieties in shape and colour described by Rostafinski under the names of *C. vulgare*, *C. pyriforme*, *C. minutum*, and *C. Friesii* may arise from one source, and no specific characters appear to exist to separate the four forms. In examination of the type specimen of *C. Oerstedtii* in the Strassburg Herbarium no character was observed to distinguish it from the present species; the sporangia are pyriform, and yellow-brown; no lid remains attached to a sporangium, but it is described as white; the capillitium resembles that met with in most forms of *C. minutum*; a distinct pseudo-columella is present. Specimens from America are mostly of a dark olive colour, somewhat small in size,



and without a pseudo-columella. The most frequent form in Europe is perhaps the var. *confusum* Rost. in the Strassburg Herb.; it is rather broad in shape, and yellow-brown. When old and weathered the sporangia are apt to lose their colour and become white. In abnormal developments they may be sessile or form short plasmodiocarps; but there appears to be always some differentiation into a lid in the upper part of the sporangium-walls.

*Hab.* On dead leaves, sticks, etc., common.—Lyme Regis, Dorset (B.M. 1272); Batheaston, Somerset (B.M. 179); Yorks (B.M. 1057); Penzance (B.M. 24); Wales (B.M. 2354); France (B.M. 469); Germany (B.M. 473); Sweden (K. 1359); Italy (K. 257); Hungary (K. 1362); Madeira (K. 1363); Nigeria (Coll. W. G. Freeman); Ceylon (B.M. 472); West Australia (K. 1360); Tasmania (K. 1367); New Zealand (B.M. 2355); Japan (B.M. 2356); Iowa (B.M. 1274); Philadelphia (B.M. 1902); Colorado (B.M. 2357).

2. **C. concinnum** Rex in Proc. Acad. Nat. Sci. Phil., 1893, 370. Plasmodium yolk-coloured. Total height 0.5 to 0.7 mm. Sporangia broadly funnel-shaped or goblet-shaped, stalked, 0.2 to 0.5 mm. diam., smooth, pinkish-red or olive-brown, often paler above, opening by a well-defined convex paler lid; sporangium-wall cartilaginous. Stalk red or brown, 0.1 to 0.2 mm. long. Columella none. Capillitium consisting of numerous brown angular lime-knots, connected by short and sparingly branched hyaline threads. Spores purplish-brown, minutely warted, 8 to 9  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 78.

Pl. 79.—*a.* *b.* sporangia of various shapes (Philadelphia); *c.* capillitium and spores, with fragment of sporangium-wall; *d.* spore.

This species is allied to *C. minutum*, but differs in the smaller size, the brown lime-knots, and the browner spores.

*Hab.* On the burrs and leaves of *Castanea sativa* Mill. var. *americana*.—Philadelphia (B.M. 1939); Poquonock, Connecticut (B.M. 2358).

3. **C. paraguayense**. Lister. Plasmodium? Sporangia stalked, gregarious, goblet-shaped or cylindrical with a convex apex, erect, 0.7 to 0.8 mm. high 0.3 to 0.6 mm. broad, rugose, bright reddish-violet reticulated with a paler shade; on maturity the apex falls away, separating by an irregular line, and not forming a distinct lid; sporangium-wall cartilaginous, composed of two closely connected layers with deposits of pale violet lime-granules distributed throughout but chiefly concentrated in pouch-like cavities of the wall, causing the effect of pale reticulations in the opaque object. Columella irregular or cylindrical, pale violet, charged with lime throughout. Stalk cylindrical, 0.4 mm. high, 0.07 mm. thick, plicate, purple, opaque, arising from a disc-shaped hypothallus. Capillitium consisting of pale violet threads connecting large violet lime-knots that combine in the centre of the sporangium to form a columella which is either

connected with or free from the apex of the stalk. Spores violet, nearly smooth, 8 to 9  $\mu$  diam.—*Didymium paraguayense* Spegaz. in Anal. Soc. Cient. Argent., xxii. 186 (1886); Mass. Mon., 250. *D. guarapiense* (errore) Spegaz. l.c., xxvi. 60. *Craterium rubescens* Rex in Proc. Acad. Nat. Sci. Phil., 1893, 370; Lister Mycetozoa, 71; Macbr. N. Am. Slime-Moulds, 75. *Iocraterium rubescens* Jahn in Hedw., xliii. 302, fig. 1, A to E (1904). *Iocraterium paraguayense* Torr end Fl. Myx., 174 (1909).

Pl. 80.—*a.* sporangia (Brazil); *b.* a sporangium with broken walls showing the columella; *c.* capillitium and spores; *d.* sporangia (Paraguay); *e.* capillitium and spores of the same with fragment of sporangium-walls; *f.* spore.

This species has been placed by Dr. Jahn in a new genus, *Iocraterium*, on the ground that the central mass of confluent lime-knots is connected with the apex of the stalk, and thus forms a true columella; but this character does not appear to be constant, and is not evident in the type of *C. rubescens* Rex from Louisiana.

*Hab.* On dead leaves.—Louisiana (B.M. slide); Paraguay (B.M. 1002A); Brazil (B.M. 2359).

4. *C. leucocephalum* Ditm. in Sturm Deutsch. Fl., Pilze, 21, t. 11 (1813). Plasmodium rich yellow. Total height 1 mm. Sporangia ovoid or turbinate, stalked, erect, 0.7 mm. high, 0.4 to 0.6 mm. broad, red-brown with white incrustations of lime and usually spotted with minute yellow warts on the upper half; in abnormal developments plasmodiocarp forms may occur. Lid white, convex. Sporangium-wall thin, consisting of two closely connected layers; the outer yellow, provided in the upper part with scattered lime-deposits and studded with shallow often colourless pouches containing dense aggregations of white lime-granules, and associated with yellow crystalline disc-shaped bodies; the lower part cartilaginous, translucent, of deeper colour, and continued into the stalk; the inner layer membranous and colourless. Stalk cylindrical, plicate, 0.3 to 0.5 mm. long, red-brown, translucent, cartilaginous, rising from a circular hypothallus. Columella either absent or represented by a central mass of confluent lime-knots. Capillitium consisting of large, irregularly shaped white or yellowish lime-knots, connected by yellow branching hyaline threads, with frequent flattened expansions at the axils. Spores violet-brown, spinulose, 7 to 9  $\mu$  diam.—Fr. Syst. Myc., iii. 153; Rost. Mon., p. 123; Mass. Mon., 267; Macbr. N. Am. Slime-Moulds, 76. *Stemonitis leucocephala* Pers. in Gmel. Syst. Nat., 1467 (1791). *Peziza convivale* Batsch Elench. Fung., 121 (1783)? *Arcyria leucocephala* Hoffm. Fl. Crypt. Germ., t. 6 (1795). *Physarum leucostictum* Chev. Fl. Paris, i. 336 (1826)? *P. xanthopus* Wallr. Fl. Crypt. Germ., ii. 358 (1833). *Craterium deoperculatum* Fr. in Weinm. Hymen. & Gasterom., 597 (1836).

*C. pruinoseum* Corda Ic., vi. 13, t. ii, f. 33 (1854). *C. Fuckelii* Mass. l.c., 272 (1892). *C. convivale* Morg. Myx. Miami Valley, 86 (1896).

Var. 1.—*cylindricum* Lister : sporangia cylindrical, nearly white with a reddish-brown base, the wall often without crystalline discs.—*C. minimum* Berk. & Curt. in Grev., ii. 67 (1873); Mass. Mon., 272; Macbride N. Am. Slime-Moulds, 77. *C. cylindricum*, Mass. l.c., 268 (1892).

Var. 2.—*scyphoides* Lister : sporangia turbinate, the wall thickened and rufous at the base, membranous and grey above, dehiscing irregularly and not by a distinct lid.—*Physarum scyphoides* Cooke & Balf. in Rav. N. Am. Fung., no. 480; Mass. in Journ. Myc., v. 186, t. xiv, fig. 7; Mass. Mon., 282.

Pl. 82.—*a. b.* sporangia of various shapes; the wall of the middle one in *b.* is broken and shows a pseudo-columella (England); *c.* sporangia of var. *cylindricum* (Ceylon); *d.* sporangia of var. *scyphoides* (Georgia, U.S.A.); *e.* spores and capillitium with fragment of sporangium-wall showing crystalline discs; *f.* spore.

The yellow crystalline bodies above mentioned are a marked feature in this species. In the typical form they are present in the sporangium-wall, in the lime-knots and columella. They can easily be detected by treating the sporangia with xylol. Those in the wall are either nearly superficial or are embedded in its substance; they are usually disc-shaped with a crenate margin, measuring 15 to 40  $\mu$  diam., and marked with lines radiating from the centre; those in the lime-knots are somewhat globular, varying from 5 to 20  $\mu$  diam., and are often in clusters; they dissolve rapidly in dilute carbolic acid. The vars. *cylindricum* and *scyphoides* have been regarded by some authors as distinct species, but the characters distinguishing them from the typical form of *C. leucocephalum* are very slight, and many intermediate links occur; they have the characteristic discs in the lime-knots, but not as a rule in the sporangium-wall. The specimen issued by Fuckel as *C. mutabile* Fr., Fung. Rhen. Exs. no. 1455 (B.M. 481) (type of *C. Fuckelii* Mass.), is a subglobose form of the present species with the lime in the sporangium-wall almost absent; the spores measure 9 to 10  $\mu$  diam., and are minutely spinulose.

*Hab.* On dead leaves and twigs. Common.—Wanstead, Essex (B.M. 1275); Luton, Beds (B.M. 1276); Lyme Regis, Dorset (B.M. 1277); France (K. 282); Germany (B.M. 471); Switzerland (B.M. 2362); Austria (B.M. 2361); Italy (K. 297); Portugal (B.M. 2360); Adirondack Mountains, New York (B.M. 1908); Washington State (B.M. 2363); Antigua (B.M. 1659); var. *cylindricum*—Ceylon (B.M. 480); Java (B.M. 2364); Japan (B.M. 2365); Ohio (B.M. 1278); var. *scyphoides*—Georgia (B.M. 455); Worcester, Mass. (B.M. 2366); Galapagos Islands (B.M. 2367).

5. *C. aureum* Rost. Mon., p. 124 (1875). Plasmodium lemon-yellow. Sporangia gregarious, obovoid, ovoid or globose, 0.4 to 0.6 mm. diam., stalked, erect, rugose, golden-yellow or greenish, fading almost to white on exposure, without a defined lid, breaking up at maturity in the upper part into areolae, or dehiscing almost to the base in stellate

lobes; sporangium-wall single, membranous, with deposits of included yellow lime-granules which are denser and of a deeper yellow on the summit, somewhat stouter and more persistent at the base where it is continued into the cartilaginous stalk. Stalk cylindrical, 0.2 to 0.5 mm. long, stout, deeply furrowed, nearly translucent, but charged with lime-granules, orange or yellow, arising from a circular hypothallus. Columella either absent or represented by a central mass of confluent lime-knots. Capillitium of irregularly shaped yellow lime-knots, varying much in size, connected by a network of hyaline threads with triangular expansions at the axils of the branches. Spores violet-brown, spinulose, 8 to 9  $\mu$  diam.—Mass. Mon., 269; Macbr. N. Am. Slime-Moulds, 73. *Trichia aurea* Schum. Enum. Pl. Saell., ii. 208 (1803). *Craterium mutabile* Fr. Syst. Myc., iii. 154 (1829) (*non* Symb.), Gast.; Wallr. Fl. Crypt. Germ., ii. 357; Lister Mycetozoa, 73.

Pl. 67.—*a.* sporangia (Devon); *b.* capillitium and spores with fragment of sporangium-wall; *c.* spore.

This species holds an intermediate position between the genera *Physarum* and *Craterium*; it is retained somewhat doubtfully in the present genus on account of the usually ovoid sporangia having the wall cartilaginous at the base, and from its general resemblance to *C. leucocephalum*. It is nearly allied to *P. citrinellum* Peck, but differs in the shape of the sporangia, in the orange-yellow stalks, and in the smaller spores. A specimen gathered by Mr. W. G. Freeman, on leaves, at Onitcha Olona, South Nigeria, in 1904 (B.M. 2372), is probably a form of the present species, though in the structure of the stalk it shows affinities with *P. sulphureum*; the sulphur-yellow obovoid sporangia tend to expand on maturity in a stellate manner, and have a columella which in some cases is attached to the apex of the stalk, and in others is free; the spores measure 7 to 8  $\mu$ ; the stalks are nearly white, and are brittle from dense deposits of enclosed white lime-granules.

*Hab.* On dead leaves.—Lyme Regis, Dorset (B.M. 1280); Flitwick, Beds (B.M. 1281A); Batheaston, Somerset (B.M. 133); North Wales (B.M. 2368); Appin, Scotland (K. 299); near Paris (B.M. 2369); Germany (Strassb. Herb.); Portugal (B.M. 2370); Ceylon (Peradeniya Herb.); Japan (B.M. 2371); Ohio (B.M. 1282); South Carolina (B.M. 888).

Genus 10.—**LEOCARPUS** Link in Mag. Ges. Nat. Fr. Berl., iii. 25 (1809). Sporangium-wall of two layers, the outer cartilaginous, shining, with deposits of lime on the inner side, the inner hyaline. Capillitium consisting of a network of rigid hyaline threads, with branched anastomosing brownish lime-knots.

1. *L. fragilis* Rost. Mon., p. 132, fig. 93 (1875). Plasmodium lemon-yellow. Sporangia clustered, obovoid or globose, sessile or shortly stalked, 2 to 4 mm. long, yellowish-brown, chestnut or purple-brown, shining as if varnished, sometimes dehiscing in revolute floriform lobes; the outer

layer of the sporangium-wall cartilaginous, orange-brown, usually with dense deposits of lime-granules on the inner side, the inner layer a firm hyaline membrane, giving attachment to the capillitium. Columella none. Stalk short, weak, yellowish, translucent, arising from a membranous hypothallus. Capillitium a network of rigid hyaline threads with flattened expansions at the axils, connected with angular branching and anastomosing brown lime-knots. Spores spinulose, 11 to 13  $\mu$  diam., occasionally 15 to 20  $\mu$  diam., sometimes slightly clustered, violet-brown or dark brown, with a pale spot where dehiscence occurs.—Mass. Mon., 338; Macbr. N. Am. Slime-Moulds, 81. *Lycoperdon fragile* Dicks. Pl. Crypt. Brit., i. 25, t. iii, fig. 5 (1785). *Diderma vernicosum* Pers. in Usteri Ann. Bot., xv. 34 (1795). *D. atrovirens* Fr. Syst. Myc., iii. 103 (1829). *Trichia lutea* Trentep. in Roth Catal. Bot., i. 230 (1797). *Physarum nitidum* Schum. Enum. Pl. Saell., ii. 205 (1803). *P. vernicosum* Schum. l.c., 206. *Leocarpus vernicosus* Link l.c.; Lister Mycetozoa, 75. *L. spermoides* Link l.c. *L. atrovirens* Fr. Symb. Gast., 13 (1817). *L. ramosus* Fr. Summ. Veg. Scand., 450 (1849). *Tripotrichia elegans* Corda Icon. Fung., i. 22, t. vi. f. 288A (1837).

Pl. 81—a. sporangia (England); b. capillitium and spores with fragment of sporangium-wall; c. spore.

The plasmodia of this species are frequently large. When about to change into fruit they become orange-yellow, and often creep for a considerable distance from their feeding grounds; sporangia have been found in one instance some feet up the trunk of a larch tree, and on another occasion among the upper branches of a small furze bush. Although abundant in temperate regions it does not appear to be common in the tropics.

*Hab.* On dead leaves, twigs, etc.—Hornsey, Middlesex (B.M. 22); Epping Forest, Essex (B.M. 1285); Lyme Regis, Dorset (B.M. 1284); near Edinburgh (B.M. 1061); France (B.M. 2373); Portugal (B.M. 2374); Belgium (B.M. 482); Germany (B.M. 1059); Bohemia (B.M. 489); Finland (B.M. 491); East Tibet (Edinburgh Herb.); Tasmania (K. 1390); Massachusetts (B.M. 1859); Iowa (B.M. 818); Colorado (B.M. 2375); South Carolina (B.M. 495); New Grenada (B.M. 1060).

Genus 11.—**DIDERMA** Persoon in Roemer N. Mag. Bot., i. 89 (1794). Sporangia stalked, sessile, or forming plasmodiocarps; sporangium-wall of two layers (single in *D. simplex*), containing granular deposits of lime (except in *D. Trevelyani*, q.v.). Columella usually present. Capillitium threads simple or branched, without lime-knots.

#### KEY TO THE SPECIES OF *DIDERMA*.

Subgenus 1.—**EUDIDERMA**: outer sporangium-wall a smooth crust composed of lime granules densely compacted (except in *D. simplex*); inner layer membranous (see also No. 13).

- A. Spores reticulated. 1. *D. subdictyospermum*
- B. Spores not reticulated—
- a. Sporangia white—
- Sporangia disc-shaped, stalked.
2. *D. hemisphericum*
- Plasmodiocarps flat; columella brownish flesh-coloured.
3. *D. effusum*
- Sporangia hemispherical; columella white, convex; inner sporangium-wall rarely persistent; spores violet-brown, 7–10  $\mu$ .
4. *D. spumarioides*
- Sporangia subglobose; columella small, convex, white; outer sporangium-wall shell-like, separating from the persistent colourless inner wall; spores purplish-brown, 11–14  $\mu$ .
5. *D. globosum*
- Sporangia subglobose or ovoid (or forming plasmodiocarps in subsp. *deplanatum*); columella subglobose or clavate, orange, red-brown, or pale, absent in plasmodiocarp forms; inner wall persistent, orange below; spores purplish-brown, 9–14  $\mu$ .
6. *D. niveum*
- b. Sporangia flesh-coloured, depressed. 7. *D. testaceum*
- c. Sporangia reddish clay-coloured or brownish buff; wall single. 8. *D. simplex*

Subgenus 2.—LEANGIUM: sporangium-wall cartilaginous.\*

- A. Sporangium-wall brown externally, white and crystalline on the inner side; columella often absent.
11. *D. Trevelyani*
- B. Sporangium-wall without a crystalline layer—
- a. Spores with widely scattered warts; sporangia stalked.
12. *D. floriforme*
- b. Spores closely spinulose or nearly smooth—
- Sporangia pinkish-brown, sessile, subglobose; columella indefinite; capillitium usually colourless.
9. *D. Sauteri*
- Sporangia ochraceous, sessile, subglobose or ring-shaped; columella indefinite; capillitium purple-brown.
10. *D. ochraceum*
- Sporangia white, grey or brown; columella pale, hemispherical; stalk stout, ochraceous.
13. *D. radiatum*

\* Sporangium-wall as in *Eudiderma* in the white forms of *D. radiatum*.

Sporangia mottled, brown; columella convex, ochraceous; stalk black. 14. *D. roanense*

Sporangia brown, marked with close radiating dark lines, usually sessile, hemispherical; columella white, convex. 15. *D. asteroides*

Sporangia and clavate columella white; stalk slender, black. 16. *D. rugosum*

Sporangia bright orange; columella clavate or globose; stalk dark brown. 17. *D. lucidum*

Subgenus 1.—EUDIDERMA: sporangia sessile (or stalked in Nos. 2 and 6); sporangium-wall dehiscing irregularly, consisting of two layers (except in No. 8), the outer layer a smooth crust of globular lime-granules, the inner layer membranous.

1. *D. subdictyospermum* Lister. Plasmodium? Sporangia crowded, subglobose or hemispherical, sessile, 0.3 to 0.5 mm. diam., snow-white, seated on a well-developed white hypothallus; sporangium-wall thick, fragile, composed of an outer crust of globular lime-granules closely adhering to the delicate membranous inner layer. Columella hemispherical or subglobose, white. Capillitium consisting of somewhat rigid purplish sparingly branched threads, anastomosing near the extremities. Spores 10 to 12  $\mu$  diam., violet-brown, reticulated with raised ridges or with broken bands that form a border about 2  $\mu$  broad.—*Chondrioderma subdictyospermum* Rost. Mon., App. p. 16 (1876); Lister Mycetoza, 77; Penzig Myx. Buit., 44. *C. dealbatum* Mass. Mon., 207 (1892). *Didymium dealbatum* Berk. & Curt. in herb.

Pl. 87.—*d.* sporangia (Venezuela); *e.* capillitium and spores; *f.* spores.

This species appears to be allied to *D. spumarioides*, but differs essentially in the reticulated spores. The type from Venezuela (B.M. 570), marked in Berkeley's herbarium "*Didymium dealbatum*," remained undescribed until Rostafinski published it as *Chondrioderma subdictyospermum*; in this specimen the spores are provided with protuberances either irregularly disposed or combined into an incomplete net. Two other gatherings have been obtained, one from the Cape, the other from Java; in these the spores are regularly reticulated with raised bands.

*Hab.* On moss and dead leaves.—Cape (K. 466); Java (B.M. 2812); Venezuela (B.M. 570).

2. *D. hemisphericum* Hornem. Fl. Dan., fasc. xxxiii. 13 (1829). Plasmodium opaque white. Sporangia scattered, flat, disc-shaped on a central stalk, 1 to 1.25 mm. diam., rarely sessile and confluent, chalk-white; sporangium-wall of two layers on the flat upper surface, the outer a smooth crust composed of globular lime-granules 1 to 3  $\mu$  diam., easily separating and breaking away from the more persistent

membranous inner layer; under surface rugose, thickened. Stalk ochraceous or brownish, 0.2 to 0.8 mm. long, 0.25 mm. thick, furrowed with wrinkles which are continued over the flat under side of the sporangium, densely calcareous, often seated on a white hypothallus. Columella indefinite, consisting of the broad thickened base of the sporangium, flesh-red or flesh-brown, charged with calcareous deposits in the form of nodules and large rhomboidal crystals. Capillitium consisting of slender colourless threads, variously branched and anastomosing, or of violet-brown threads 1 to 2  $\mu$  thick, sparingly branched except at the pale extremities. Spores pale violet-brown, almost smooth, 7 to 9  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 101 (1899). *Reticularia hemispherica* Bull. Champ., 93, t. 446, fig. 1 (1791), in part; Sow. Engl. Fung., t. 12. *Physarum depressum* Schum. Enum. Pl. Saell., ii. 202 (1803); *P. Michelii* Corda Icon. Fung., v. p. 57, tab. iii, fig. 33 (1842). *Didymium hemisphericum* Fr. Syst. Myc., iii. 115 (1829), in part. *D. Michelii* Lib. Pl. Arduen. Exsic., fasc. ii. no. 180 (1832). *Diderma depressum* Fr. l.c., 108? *Chondrioderma Michelii* Rost. in Fuckel Symb. Myc., Nachtr., ii. 74 (1873); Rost. Mon., p. 172; Mass. Mon., 204; Lister Mycetozoa, 79. *C. Friesianum* Rost. l.c., 172? *C. hemisphericum* Torrend Fl. Myx., 163 (1909).

Pl. 83.—*a.* sporangia (England); *b.* capillitium with fragment of sporangium-wall and spores; *c.* capillitium of stouter form; *d.* nodules of lime from the stalk; *e.* spore.

This species is abundant in the British Isles. It differs from *Diderma effusum* in the larger discoid sporangia being provided with stout pale stalks, which are rarely entirely absent in any development. *D. depressum* Fr. is described as having regular orbicular sessile sporangia with a thick white fugaceous outer peridium; it was probably a sessile form of the present species, but may possibly be referred to *D. effusum*.

*Hab.* On dead leaves and twigs.—Lyme Regis, Dorset (B.M. 1298); Batheaston, Somerset (B.M. 47); Yorks (B.M. 1112); France (Paris Herb.); Belgium (B.M. 513); Germany (Strassb. Herb.); Sweden (K. 1449); Portugal (B.M. 2376); Ceylon (K. 1440); Java (Herb. Penzig); South Carolina (B.M. 890); Pennsylvania (B.M. 1299); California (B.M. 2377); Antigua (B.M. 1661).

3. *D. effusum* Morg. Myx. Miami Valley, 71 (1894) (*non* Link). Plasmodium white. Sporangia sessile, gregarious, much depressed, smooth, white, either rounded, 0.7 mm. diam., or more usually forming elongated and flat branching net-like or effused plasmodiocarps, sometimes 6 cm. long and 1 cm. or more broad; sporangium-wall of two layers, the outer a thin fragile crust of globular lime-granules, separating from the membranous colourless inner wall. Columella pulvinate, depressed, brownish flesh-coloured, enclosing white lime-granules. Capillitium consisting of delicate colourless or pale purplish



threads, sparingly branched and anastomosing. Spores pale violet-brown, nearly smooth, 6 to 8  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 94. *Physarum effusum* Schwein. in Trans. Am. Phil. Soc., n.s. iv. 257 (1832). *Didymium reticulatum* Rost. in Fuckel Symb. Myc., Nachtr. 2, p. 73 (1873). *Chondrioderma reticulatum* Rost. Mon., p. 170 (1875); Mass. Mon., 216; Lister Mycetozoa, 79; Petch in Ann. Perad., iv. 344. *C. Saundersii* Berk. & Br. in litt.; Mass. Mon., 209 (1892). *Diderma reticulatum* Morg. l.c., 71; Macbr. l.c., 95.

Pl. 83.—*f.* orbicular and plasmodiocarp forms of sporangia (Philadelphia).

The species published by Morgan as *Diderma effusum* was so named after it had been shown by Dr. Rex to be similar to the Schweinitzian type of *Physarum effusum*. Morgan's graphic description leaves no doubt that his specimens were the reticulate and effused form of the present species, which has usually been distributed under the name *Chondrioderma reticulatum* Rost.; by the rule of priority Schweinitz's specific name must be retained. *Diderma effusum* is closely allied both to *D. hemisphericum* (q.v.) and to *D. testaceum*; from the latter it is distinguished by the more frequent plasmodiocarp habit, the flatter sporangia and the absence of any rosy tinge in the sporangium-wall and columella. Ceylon gatherings, marked "75. *Diderma depressum* Fr." (B.M. 514; K. 1438, 1439), showing flattened white plasmodiocarps with brownish flesh-coloured columella, must be referred to the present species; so also must the type of *Chondrioderma Saundersii* Berk. & Br. from Java (B.M. 1962), in which the flat plasmodiocarps are effused over the under side of pinnules of a species of *Adiantum*.

*Hab.* On dead leaves and twigs.—Flitwick, Beds (B.M. 1300); Epping Forest, Essex (B.M. 2378); Wilts (B.M. 2381); Switzerland (B.M. 2379); Germany (B.M. 2380); Portugal (B.M. 2383); Ceylon (B.M. 514); Java (B.M. 1962); Japan (B.M. 2000); Ohio (B.M. 1302); New Hampshire (B.M. 1301); Iowa (B.M. 1022); Argentina (B.M. 2382).

4. *D. spumarioides* Fries Syst. Myc., iii. 104 (1829). Plasmodium opaque white. Sporangia crowded, globose, sessile, 0.5 to 1 mm. diam., smooth or rugose, white; often seated on a strongly developed white hypothallus; sporangium-wall of two layers, the outer thick, fragile, composed of globular lime-granules 1 to 2  $\mu$  diam., more or less adhering to the membranous inner layer. Columella convex or hemispherical, white or pale flesh-coloured. Capillitium consisting of slender flexuose purplish threads, branching at an acute angle and somewhat anastomosing. Spores violet-brown, spinulose, 8 to 11  $\mu$  diam.—Morgan Myx. Miami Valley, 67; Macbr. N. Am. Slime-Moulds, 97. *Didymium spumarioides* Fr. Symb. Gast., 20 (1818); Mass. Mon., 232. *Reticularia sphaeroidalis* Bull. Champ., 94, t. 446, fig. 2 (1791)? *Spumaria physaroides* Pers. Syn., 163 (1801)? *Physarum sphaeroidale* Chev. Fl. Paris, i. 339 (1826)? *P. stromateum* Link Handb., iii. 409 (1833). *Carcarina spumarioides* Fr. Summ.

Veg. Scand., 451 (1849). *Chondrioderma spumarioides* Rost. Mon., p. 174 (1875); Lister Mycetozoa, 76. *C. stromateum* Rost. Mon., App. p. 18 (1876). *C. virgineum* Mass. l.c., 207 (1892). *Diderma cinereum* Morg. Myx. Miami Valley, 70 (1894); Macbr. N. Am. Slime-Moulds, 101. *D. stromateum* Morg. l.c., 68.

Pl. 84.—*a.* sporangia (England); *b.* capillitium and spores with fragment of sporangium-wall; *c.* spore.

This species is closely allied to *D. globosum* with which it is connected by intermediate forms; it differs in having the layers of the sporangium-wall more closely connected and in the smaller smoother spores. The latter, being a microscopic character, could not be observed by the earlier authors, who probably confused the two species. The type of *C. virgineum* Mass. from Hampstead, Middlesex (K. 560), is a form of *D. spumarioides* without hypothallus; the capillitium in some sporangia is normal, in others there are the expansions described by Masee. The specimen named *C. stromateum* by Rostafinski in the Strassb. Herb. from Lochem (*leg.* Spree, Rab. Fung. Eur., no. 432, B.M. 515); does not present any character by which it can be separated from the present species. In gatherings made by Mr. Petch in Ceylon the mature sporangia have their walls cracked into concave polygonal areolae, whose edges form polygonal ridges (see Petch in Ann. Perad., iv. 343); a similar mode of dehiscence occurs in a gathering made by Mr. A. F. Blakeslee in Venezuela (B.M. 2391); in other respects these specimens are typical of the present species.

*Hab.* On dead leaves. Common in the British Isles.—Lyme Regis, Dorset (B.M. 1287); Wanstead Park, Essex (B.M. 2384); Flitwick, Beds (B.M. 2385); North Wales (B.M. 2386); Ireland (B.M. 2387); Sweden (B.M. 2388); France (K. 37); Germany (B.M. 515); Portugal (B.M. 2389); Ceylon (B.M. 2390); New York (B.M. 886); New Hampshire (B.M. 1288); Washington State (B.M. 2393); Colorado (B.M. 2392); Antigua (B.M. 1660); Venezuela (B.M. 2391).

5. *D. globosum* Pers. in Roemer N. Mag. Bot., i. 89, t. iv, figs. 4, 5 (1794). Plasmodium white. Sporangia globose, sessile, crowded, 0.5 to 0.8 mm. diam., smooth, white or cream-coloured; usually seated on a strongly developed white or cream-coloured hypothallus; sporangium-wall of two layers, the outer eggshell-like, composed of globular lime-granules 1 to 2  $\mu$  diam., often separating widely from the membranous inner layer. Columella hemispherical or subglobose, usually minute, white or pale flesh-coloured. Capillitium consisting of slender irregularly branched and anastomosing pale purplish threads, often with irregular expansions towards the base enclosing a few lime-granules. Spores dark purplish-brown, spinulose, 10 to 14  $\mu$  diam. — Macbr. N. Am. Slime-Moulds, 97. *D. crustaceum* Peck in Rep. N. York Mus., xxvi. 74 (1874); Macbride l.c., 98. *Didymium candidum* Schrad. Nov. Pl. Gen., 25 (1797)? *D. globosum* Chev. Fl. Paris, i. 334 (1826)? *Chondrioderma globosum* Rost. Mon., p. 180 (1875); Mass. Mon., 206; Lister Mycetozoa, 78. *C. affine*

Rost. Mon., App. p. 18 (1876); Mass. l.c., 210. *C. similans* Rost. l.c., p. 20; Mass. l.c., 209. *C. crustaceum* Berlese in Sacc. Syll., vii. 373 (1888); Mass. l.c., 215. *C. frustulosum* Pat. in Bull. Herb. Boiss., iii. 61 (1895)?

Pl. 85.—*a.* sporangia seated on a stout hypothallus (Poland); *b.* capillitium and spores with fragment of sporangium-wall; *c.* spore.

Rostafinski describes the spores of *Chondrioderma globosum* as "pale violet, 8  $\mu$  diam.," but the specimen from Warsaw in the Strassburg herbarium marked with this name in his handwriting (referred to Rost. Mon., p. 180) has dark rough spores, 11 to 13  $\mu$  diam. Whether Rostafinski had seen other specimens corresponding with his description remains uncertain; such forms have been occasionally met with in the United States (Macbr. l.c., 98), and appear to lie on the border line between *D. globosum* and *D. spumarioides*. The type of *C. affine* Rost., also from Warsaw, is similar in all respects to the Warsaw gathering of *D. globosum* above referred to. Specimens of the present species gathered on the Swiss Alps show interesting transitional forms; on the one hand they may approach *D. spumarioides* in having spores only 10  $\mu$  diam., and on the other they may resemble *D. niveum* in the pale orange tint of the floor of the sporangia; the latter are often elongated to form short plasmodiocarps. (See Meylan in Bull. Soc. Vaud., xliv. 289, 1908.)

*Hab.* On dead leaves and twigs.—Holt, Norfolk (B.M. 2394); France (B.M. 2398); Strassburg (B.M. 1289); Sweden (B.M. 2395); Poland (Strassb. Herb.); Italy (B.M. 525); Switzerland (B.M. 2396); British Columbia (B.M. 2397); Kansas (B.M. 2399); Colorado (B.M. 2400); Iowa (B.M. 816); New Hampshire (B.M. 1288).

6. *D. niveum* Macbr. N. Am. Slime-Moulds, 100 (1899). Plasmodium white. Sporangia crowded, subglobose, or hemispherical, sessile, 0.7 to 1.5 mm. diam., smooth, white, sometimes seated on a white or dull yellow hypothallus; sporangium-wall of two layers, the outer densely charged with white lime-granules, separating from the more persistent inner layer, which is membranous and often iridescent above, cartilaginous and orange below. Columella broad, convex, or hemispherical, orange or buff. Capillitium of branching and anastomosing rather stout purple threads with pale extremities, sometimes intermixed with more delicate threads, and often beaded with wart-like thickenings. Spores purple-brown, minutely spinulose, 9 to 13  $\mu$  diam.—*Chondrioderma niveum* Rost. Mon., p. 170 (1875); Mass. Mon., 206; Lister Mycetozoa, 80. *C. physaroides* Rost. l.c.; Mass. l.c., 214. *C. albescens* Mass. l.c., 209 (1892). *Diderma albescens* Phill. in Grev., v. 114 (1877).

Subsp. 1.—*Lyallii* Lister: sporangia subglobose or obovoid, white or pale ochraceous, 1 to 1.5 mm. diam., sessile or on short stout furrowed whitish stalks arising from a well developed hypothallus; columella hemispherical or clavate, ochraceous; spores purple-brown, spinose, 11 to 15  $\mu$  diam.—

Lister in Journ. Bot., xlv. 217. *Chondrioderma Lyallii* Mass. Mon., 201 (1892); Lister Mycetozoa, 81. *Diderma Lyallii* Macbr. l.c., 99 (1899).

Subsp. 2.—*deplanatum* Lister: sporangia white or cream-coloured, forming curved ring-shaped or net-like plasmodiocarps; columella none, or represented by the thickened orange base of the sporangium-wall; spores 9 to 10  $\mu$ .—*Diderma deplanatum* Fr. Syst. Myc., iii. 110 (1829); Berk. in Sm. Engl. Fl., v. pt. 2, 312. *D. contortum* Hoffm. Fl. Crypt. Germ., iii. tab. 9, fig. 2a (1795)? *Chondrioderma deplanatum* Rost. Mon., App. p. 17 (1876). *C. mutabile* Schroet. in Cohn Krypt. Fl. Schles., iii. pt. 1, 123 (1885)?

Pl. 89.—*a.* sporangia (Vosges); *b.* capillitium and spores with fragment of sporangium-wall; *c.* spore; *d.* ring-shaped plasmodiocarp of subsp. *deplanatum*, sporangium-wall partly broken away (England).

Pl. 90.—subsp. *Lyallii*: *a.* sporangia (Switzerland); *b.* capillitium and spores with fragment of sporangium-wall; *c.* spore.

This species displays three well-marked phases. The type and the subsp. *Lyallii* are essentially alpine forms, and occur in great abundance on the turf of alpine pastures in springtime close to the edge of melting snow; connecting forms showing great variety in the shape of the columella and size of the spores are frequently found (see R. E. Fries in Arkiv. Bot., vi. no. 7, pp. 2, 8; Meylan in Bull. Soc. Vaud., xlv. 290). The subsp. *deplanatum* is the lowland phase of the species; it is not uncommon in this country. While some gatherings of this subspecies have a definite columella and closely approach the type of *D. niveum*, others show affinity with *D. effusum* in having more slender depressed plasmodiocarps. The specimen in Berkeley's collection from Linlithgow named by him *Diderma cyanescens* Fr., and by Rostafinski *Chondrioderma niveum* (K. 1435), is the subsp. *deplanatum*, having the lower part of the inner wall and base orange, and the columella depressed; it has the same rigid warted threads as the typical form. *D. contortum* Hoffm. is cited by Fries as a synonym for his *D. deplanatum*, but it is somewhat doubtful from the figure and description if they refer to the present species or to a nearly sessile form of *D. hemisphericum*. The type of *Chondrioderma physaroides* Rost. gathered by A. de Candolle "on mountain land, close to perpetual snow," is now in the Geneva Museum; it is the typical form of the present species; so also is *Diderma albescens* Phill., gathered by Harkness on the Blue Cañon, California.

*Hab.* On turf, twigs, etc., in alpine regions; subsp. *deplanatum* on leaves and twigs on lower ground.—Near Berlin (B.M. 2401); Switzerland (B.M. 2402); Norway (B.M. slide); South Tyrol (B.M. 2404); California (B.M. 1306); subsp. *Lyallii*—Sweden (B.M. 2403); Saas, Switzerland (B.M. 1307); Jura (B.M. 2405); Oregon Boundary, U.S.A. (K. 380); subsp. *deplanatum*—Chislehurst, Kent (B.M. 27); Carlisle (B.M. 1305); Appin, Scotland (K. 410); Linlithgow (K. 1435); North Wales (B.M. 2406); Portugal (B.M. 2407).

7. *D. testaceum* Pers. Syn., 167 (1801). Plasmodium yellowish-buff (*fide* Torrend). Sporangia sessile, subglobose, depressed on a broad base, sometimes confluent, 0.8 mm.

diam., smooth, dull flesh-coloured or pale pinkish, often becoming bleached; sporangium-wall of two layers, the outer thin, brittle, egg-shell-like, composed of globular lime-granules, separating freely from the more persistent pinkish-grey membranous inner layer. Columella large, convex or hemispherical, together with the base of the sporangium flesh-coloured or reddish-brown. Capillitium consisting of delicate pale purplish branching flexuose threads. Spores pale violet-brown, almost smooth, 7 to 8  $\mu$  diam.—Fr. Syst. Myc., iii. 107; Macbr. N. Am. Slime-Moulds, 99. *Didymium testaceum* Schrad. Nov. Pl. Gen., 25, tab. v, figs. 1, 2 (1797). *Diderma cubense* Berk. & Curt. in Journ. Linn. Soc., x. 347 (1869). *D. Mariae-Wilsoni* Clinton in Rep. N. York Mus., xxvi. 74 (1874). *D. sublateritium* Berk. & Br. in Journ. Linn. Soc., xiv. 82 (1873). *Chondrioderma testaceum* Rost. Versuch, 13 (1873); Rost. Mon., p. 179; Mass. Mon., 210; Lister Mycetozoa, 78. *C. vaccinum* Rost. l.c., 180? *C. sublateritium* Rost. Mon., App. p. 19 (1876); Mass. l.c., 211. *C. cubense* Rost. l.c.

Pl. 87.—a. sporangia (Poland); b. capillitium and spores with fragment of sporangium-wall; c. spore.

The type of *Diderma sublateritium* Berk. & Br., from Ceylon (K. 1454), is more rufous in colour than is usual in the present species, though not so deep in tone as the specimen from South Carolina (B.M. 520); the capillitium and spores are typical of *D. testaceum* of which it is clearly a form. *Diderma vaccinum* Dur. & Mont. (Expl. Sci. Alger., 407 t. 22 bis. f. 1 a to h, 1846), syn. *Chondrioderma vaccinum* Rost., is described as having subglobose, bright fulvous sporangia, scanty colourless capillitium, and large hemispherical columella. Rostafinski suggests that it may be a form of *D. testaceum* (Mon. 180), but the illustrations somewhat resemble the yellower forms of *Didymium Trochus*.

*Hab.* On dead leaves and twigs.—Flitwick, Beds (B.M. 1292); North Devon (B.M. 1293); Moffat, Scotland (B.M. 1294); France (B.M. 517); Germany (B.M. 516); Poland (Strassb. Herb.); Portugal (B.M. 2408); Ceylon (B.M. 1303); Japan (B.M. 2409); California (B.M. 2410); Ohio (B.M. 1295); New York (B.M. 1296); South Carolina (B.M. 520); Cuba (B.M. 1297); Ontario (B.M. 2411.)

8. *D. simplex* Lister. Plasmodium bright yellowish-brown. Sporangia crowded or somewhat scattered, sessile, subglobose, hemispherical and often depressed, 0.3 to 0.7 mm. diam., or forming short curved plasmodiocarps, smooth or rugulose, ochraceous, reddish clay-coloured or bright chocolate-brown, sometimes seated on a well-developed hypothallus; sporangium-wall single, membranous, with abundant deposits of coloured lime-granules. Columella indefinite and rugose, or convex. Capillitium consisting of slender colourless branching threads, often beaded with lime-granules or with expansions at the base containing lime-granules. Spores

brownish-violet, minutely warted, 8 to 10  $\mu$  diam.—*Chondrioderma simplex* Schroet. in Cohn Krypt. Fl. Schles., iii. pt. 1, 123 (1885); Lister in Journ. Bot., xxxix. 85, t. 419, fig. 1 *a-d*.

Pl. 88.—*a*. sporangia (Scotland); *b*. capillitium and spores with portions of the upper sporangium-wall and of the base of the sporangium; *c*. spore; *d*. sporangia (Philadelphia).

This species occurs among moss and heath on exposed moorland, and is also found among dead leaves. The colour of the sporangia varies much in different gatherings. A specimen collected on Bartlett Mountain, New Hampshire, by Professor Thaxter (B.M. 2415) resembles *D. simplex* in general structure, but differs in the bright lemon-yellow colour of the sporangia, many but not all of which have a well-developed yellow hemispherical columella; the capillitium threads show no expansions with lime-granules. If this beautiful form should prove constant it would deserve specific rank; for the present it is retained with *D. simplex*, to which it seems most nearly allied.

*Hab.* On heather and moss, or on dead leaves.—Aberdeen (B.M. 1762); North Wales (B.M. 1551); near Berlin (B.M. 2412); New Jersey (B.M. 2413); Philadelphia (B.M. 2414); South Chili (B.M. 3194).

Subgenus 2.—*LEANGIUM*: sporangia stalked or sessile; sporangium-wall often dehiscing in revolute lobes from the globose mass of spores, and consisting of two closely connected layers, the outer layer cartilaginous, more or less charged with included lime-granules, the inner membranous.

9. *D. Sauteri* Macbr. N. Am. Slime - Moulds, 103 (1899). Plasmodium opaque white (*fide* Torrend). Sporangia sessile, somewhat aggregated, subglobose, depressed, 0.7 to 1 mm. diam., smooth, pale pinkish- or brownish-red; sporangium-wall of two layers, the outer cartilaginous, thin, brittle, somewhat glossy, charged with innate lime-granules, separating from the membranous inner layer. Columella hardly evident, a rugose thickening of the brownish-red base of the sporangium. Capillitium consisting of rather scanty, sparingly branched colourless or pale violet threads, 2 to 4  $\mu$  broad, persistent at the base. Spores dark violet-brown, spinulose, 10 to 16  $\mu$  diam.—*Chondrioderma Sauteri* Rost. Mon., p. 181 (1875); Mass. Mon., 217; Lister Mycetozaa, 83; Torrend Fl. Myx., 166. *C. aculeatum* Rex in Proc. Acad. Nat. Sci. Phil., 1891, 390.

Pl. 95.—*a*. sporangia (Portugal); *b*. sporangia (Salzburg, Tyrol); *c*. spores and capillitium, with fragments of upper sporangium-wall and columella; *d*. spore.

The specimen in the Strassburg collection originally named "*Diderma deplanatum*, ex Herb. Sauter, ad muscos in montibus Salz.," seems to be Rostafinski's type of the present species; it is well described by him as "of coffee-and-milk colour, the outer wall brittle, separating from the inner, which is membranous and colourless." The species described by Dr. Rex as *Chondrioderma aculeatum* (B.M. slide) is identical in all its characters with *D. Sauteri*. A specimen in Greville's coll. in the Edinburgh Herb. marked "*Diderma* ? Appin.

Carm." is the same form and probably part of the same gathering as K. 403, named "*Diderma melaleucum* Carm.," with a descriptive note stating that it was gathered in Scotland by Captain Carmichael; it differs from the Salzburg and American gatherings in the rather darker and larger sporangia, and in the broader, almost simple threads of the more scanty capillitium, but it appears to be the present species.

*Hab.* On dead wood and moss.—Appin, Scotland (K. 403); Salzburg, Tyrol (Strassb. Herb.); Portugal (B.M. 2416); Adirondack Mountains, New York (B.M. slide).

10. *D. ochraceum* G. C. Hoffm. Deutsch. Fl. Crypt., t. 9, fig. 2b (1795). Plasmodium lemon-yellow. Sporangia solitary or in small clusters, sessile, hemispherical, 0.7 to 1 mm. diam., often forming curved and sometimes ring-shaped plasmodiocarps, ochraceous; outer sporangium-wall somewhat cartilaginous, with abundant deposits of angular or round yellow lime-granules, adhering to or free from the firm membranous yellow inner wall. Columella indefinite. Capillitium consisting of abundant simple or branching purple-brown threads, often hyaline at the base. Spores purplish-grey, minutely spinulose, 9 to 11  $\mu$ .—*Chondrioderma ochraceum* Schroet. in Cohn Krypt. Fl. Schles., iii. pt. 1, 124 (1885); Mass. Mon., 216; Lister Mycetoza, 89, & in Journ. Bot., xxxix. 88, tab. 419, figs. 3A, and xliii. 150; Torrend Fl. Myx., 166.

Pl. 96.—a. sporangia (N. Wales); b. spores and capillitium showing attachment of threads to sporangium-wall; c. spore.

It appears probable that Hoffmann's type of the present species is represented by an unripe gathering marked "*Diderma ochraceum*" in Persoon's collection in the Leyden Herbarium. Fries writes that he had examined the type, but could not make out if the capillitium and columella were present or absent (Syst. Myc., iii. 111); he refers it doubtfully to *D. granulatum* (Schum.) Fr. Rostafinski gives both these names as synonyms for *Physarum conglomeratum* (Fr.) Rost., but Hoffmann's figure of the scattered sporangia, and his description of their being often traversed by the moss leaves on which they occur, are entirely characteristic of the present species. The appropriate specific name *ochraceum* appears to have been adopted independently by Schroeter for his Silesian gathering. *D. ochraceum* has repeatedly been found in company with *Lepidoderma tigrinum* (see Lister Mycetoza, 106), a species which it strongly resembles in capillitium and spores. Specimens of *L. tigrinum* have been found with the characteristic calcareous discs of the sporangium-wall in part replaced by angular lime-granules similar to those met with in *D. ochraceum*, and possibly we may have here varying forms of the same species. Repeated observations, however, made in a wooded ravine in North Wales, where both forms were developing daily for about a week, failed to show any connecting links; the *Lepidoderma* had always a dark orange stalk and spongy hypothallus while the *Diderma* had, as constantly, sessile sporangia and no hypothallus; the former also matured from orange and the latter from lemon-yellow plasmodium. Until we have further light, the two forms must be placed as distinct though nearly allied species.

*Hab.* On moss and liverworts on wet rocks.—North Wales (B.M. 2417); Japan (B.M. 2418); Massachusetts (B.M. slide).

11. *D. Trevelyani* Fr. Syst. Myc., iii. 105 (1829). Plasmodium? Sporangia scattered or clustered, globose or sub-ellipsoid, 1 to 1.5 mm. diam., sessile or shortly stalked, rarely forming plasmodiocarps, verrucose or nearly smooth, reddish or orange-brown; sporangium-wall either splitting irregularly or in unequal revolute petal-like lobes, white and glossy on the inner side: of three closely connected layers, the outer one cartilaginous, brown; the inner delicately membranous, giving attachment to the threads of the capillitium; the middle layer thick, composed of coarse irregular crystals of lime. Stalk furrowed, reddish-brown, 0.1 to 0.5 mm. high, 0.1 to 0.15 mm. thick. Columella subglobose, either minute, or more rarely large, but most frequently entirely absent. Capillitium profuse, purple or purplish-brown, somewhat rigid, either forming a network with dark bead-like thickenings at the nodes and on the threads, or slender, branched, with few thickenings. Spores dark violet-brown, spinulose, 10 to 13  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 102. *Leangium Trevelyani* Grev. Scot. Crypt. Fl., tab. 132 (1825). *Chondrioderma Trevelyani* Rost. Mon., p. 182 (1875); Mass. Mon., 202; Lister Mycetozoa, 82. *C. Oerstedtii* Rost. l.c., p. 184, figs. 154, 157; Mass. l.c., 203. *C. geasteroides* Phill. in Mass., l.c., 201 (1892). *Diderma geasteroides* Phill. in Grev., v. 113 (1877). *D. laciniatum* Phill., l.c. *Lepidoderma obovatum* Mass., l.c., 254?

Pl. 91.—*a.* expanded sporangia (California; type of *D. geasteroides*); *b.* entire sporangia (England); *c.* capillitium and spores with fragment of sporangium wall; *d.* spore.

The crystalline middle layer of the sporangium-wall separates this from all other species of the *Leangium* group. The type of *D. Trevelyani* described and figured under the name of *Leangium Trevelyani* Grev., is in the Edinburgh Herbarium; the sporangia are sessile on *Mnium undulatum*, and were gathered by W. C. Trevelyan, Esq., who also sent a specimen to Mr. Sowerby; the gathering named *Diderma Trevelyani*, "Sowerby Herb." (K. 1478), also on *Mnium undulatum*, is no doubt the specimen referred to. Greville speaks of and figures a "very minute columella"; Berkeley in describing Trevelyan's gathering states: "I find no trace of a columella; the bottom of the peridium within is perfectly even." Examination of the type in the Edinburgh collection confirms Berkeley's statement as far as the sporangia now remaining are concerned. That Greville was in all probability correct with regard to other sporangia of the gathering may be inferred from the variety seen in extensive developments found amongst grass on the upper pastures of the Swiss Alps; most of these sporangia are of the usual character having a smooth pearly basal inner wall and showing no trace of columella, others have a small, often eccentric columella, while others again have a large subglobose columella. Associated with normal sporangia broad plate-like plasmodiocarps sometimes occur. The



specimen from Jedburgh (K. 1477) referred to by Rostafinski as typical *Chondrioderma Oerstedtii* (see Mon., App. p. 21) has the capillitium and the structure of the sporangium similar to Greville's type of *D. Trevelyani*; these characters are also present in the types of *D. geasteroides* Phill., and *D. laciniatum* Phill. from California. It seems probable that the type of *Lepidoderma obovatum* Mass. from Sweden, is the gathering of the present species made by L. Romell at Kumla Station in August, 1885 (see Romell Fung. Exsic. no. 100: K. 459, B.M. 1783) and named by him provisionally "*Didymium subcastaneum*"; Mr. Massee's description agrees with the specimen in all respects; he states that the patches of lime are *innate* in the sporangium-wall; this feature is characteristic of the genus *Diderma* rather than of *Lepidoderma*.

*Hab.* On dead leaves, moss, etc.—Leicester ? ex Herb. Bloxam (B.M. 26); Jedburgh, Scotland (K. 1477); Northumberland (K. 1478); near Edinburgh (Edinburgh Herb.); near Berlin (B.M. 1942); Sweden (B.M. 1783); Switzerland (B.M. 2419); Colorado (B.M. 2420); California (Edinburgh Herb.).

12. *D. floriforme* Pers. in Roemer N. Mag. Bot., i. 89 (1794). Plasmodium greyish-white. Total height 1 to 2 mm. Sporangia crowded, globose, stalked, erect, smooth, 0.8 mm. diam., varying from white to ochraceous-brown; sporangium-wall splitting into several revolute petal-like lobes, pale brown on the inner side, cartilaginous, opaque, with a closely adhering membranous inner layer. Stalks cylindrical, furrowed, 0.5 to 1 mm. long, 0.15 mm. thick, ochraceous-brown, often connected below by a well-developed hypothallus. Columella ovoid or hemispherical, brown, densely calcareous. Capillitium consisting of slender sparingly branching threads with scattered bead-like thickenings, thicker and anastomosing at the base, dark violet-brown. Spores red violet-brown, paler on one side, marked with widely separated obtuse warts, 9 to 11  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 105. *Sphaerocarpus floriformis* Bull. Champ., 142, t. 371 (1791). *S. antiades* Bull. l.c., 127, t. 368, fig. 2 ? *Didymium floriforme* Schrad. Nov. Gen. Pl., 25 (1797). *Diderma spurium* Schum. Enum. Pl. Saell., ii. 197 (1803). *D. lepidotum* Fr. Syst. Myc., iii. 100 (1829). *Leangium floriforme* Link in Mag. Ges. Nat. Fr. Berl., iii. 26 (1809). *L. lepidotum* Ditm. in Sturm Deutsch. Fl., Pilze, 43, t. 21 (1817). *Physarum antiades* Fr. l.c., 135 ? *Chondrioderma floriforme* Rost. Mon., p. 184 (1875); Mass. Mon., 198; Lister Mycetoza, 85.

Pl. 92.—*a.* sporangia before dehiscence (England); *b.* sporangia after dehiscence; *c.* sporangia expanded and showing clavate columellae; *d.* capillitium and spores; *e.* spore.

The purplish-red spores with strong scattered warts distinguish this species from all forms of *D. radiatum*.

*Hab.* On dead wood.—Epping Forest, Essex (B.M. 1312); Middlesex (B.M. 2421); Woburn Sands, Beds (B.M. 2423); Wyre Forest, Worcestershire (B.M. 2422); Germany (B.M. 533); Austria (B.M. 2424); New Jersey (B.M. 1857); Ohio (B.M. 1314); Iowa (B.M. 817).

13. *D. radiatum* Lister. Plasmodium white or pale yellow, rarely coral-red. Sporangia scattered or crowded, subglobose or hemispherical and depressed, flattened or umbilicate beneath, stalked or sessile, smooth or somewhat wrinkled and rimose, 0.5 to 1.2 mm. diam., pale grey, white, brownish or red-brown; sporangium-wall dehiscing either irregularly or in a stellate manner by revolute lobes, white or pale brown on the inner side; the outer layer cartilaginous, with granular deposits of lime, not always closely connected with the membranous inner layer. Stalk ochraceous, white, or brown, 0.2 to 0.6 mm. high, usually short and stout, enclosing white lime deposits. Columella hemispherical or subglobose, 0.5 mm. diam., densely calcareous. Capillitium abundant, dark violet-brown, radiating from the columella in somewhat rigid threads, sparingly branched except at the colourless extremities, rarely pale slender and flexuose. Spores dark violet-brown, closely and minutely spinulose, 8 to 12  $\mu$  diam.—*Lycoperdon radiatum* L. Sp. Pl., ed. 2, 1654 (1763). *Didymium stellare* Schrad. Nov. Pl. Gen., 21, t. v, figs. 3, 4 (1797). *D. Geaster* Link in Mag. Ges. Nat. Fr. Berl., vii. 42 (1815). *D. complanatum* Fuck. Sym. Myc., 341 (1869). *Diderma stellare* Pers. Syn., 164 (1801); Macbr. N. Am. Slime-Moulds, 104. *D. umbilicatum* Pers. l.c., 165. *D. crassipes* Schum. Enum. Pl. Saell., ii. 196 (1803). *D. Carmichaelianum* Berk. in Sm. Engl. Fl., v. pt. 2, 311 (1836). *D. concinnum* Berk. & Curt. in Grev., ii. 52 (1873), see Journ. Bot., xxxv. 212. *Leangium stellare* Link l.c., iii. 26 (1809). *Cionium stellare* Spreng. Syst. Orb. Veg., iv. 529 (1827). *Chondrioderma radiatum* Rost. Mon., p. 182 (1875); Mass. Mon., 200; Lister Mycetozoa, 83. *C. Carmichaelianum* Cooke Myx. Brit., 42 (1877); Mass. Mon., 202, in part.

Pl. 93.—*a.* pale sporangia (Devon); *b.* sporangia dehiscing irregularly and showing the hemispherical columella; *c.* capillitium and spores with fragment of the sporangium-wall; *d.* spore.

Pl. 94.—*a.* dark sporangia with walls dehiscing in lobes (Northumberland); *b.* capillitium and spores.

This variable species presents three well-marked forms. One, represented by the type of *Lycoperdon radiatum* in the Linnean Herbarium, London, has brown often mottled sporangia whose walls dehisce in a stellate manner (fig. 94*a*). The second has pale grey or drab sporangia that dehisce irregularly (fig. 93*a*); this is the commonest form in the British Isles, and was described by Persoon as a distinct species, *D. umbilicatum*, but gatherings of intermediate character frequently occur, and Rostafinski appears to have been justified in uniting these forms under one name. A third form has nearly white sporangia; the outer layer of the wall separates easily from the membranous inner layer, and the spores measure 8 to 9  $\mu$ ; it has been named var. *album* by Torrend (Fl. Myx., 168). The development of lime varies in different gatherings and often in individuals of the same cluster; the wall instead of being obscurely granular, as is usually

the case, may be loaded with lime-granules; or the lime may be only partially present, forming a white cap to a dark sporangium, or the sporangia may be dark brown with little or no lime in the wall. The plasmodium is usually pale yellow or almost white, but a variety has been found by Dr. H. Rönn, in the neighbourhood of Kiel, with coral-red plasmodium; the resulting sporangia are of the grey form, while the lime in the stalk and columella is pale pink instead of white. The specimen in Berkeley's herbarium named *Diderma Carmichaelianum*, K. 354, is a sessile form of *D. radiatum*. No note as to locality is given; it agrees perfectly, however, with Berkeley's description of *D. Carmichaelianum*, and is probably his type from Appin, N.B. Rostafinski has marked the label "*Chondrioderma radiatum*."

The type of *Chondrioderma Stahlia* Rost. from near Strassburg does not appear in the quoted collections. It is described as follows:—Sporangia globose, brownish, glossy; sporangium-wall with scanty deposits of lime-granules, dehiscing irregularly; columella none, stalk brown, shining; the capillitium consisting of dull violet, simple or branching threads 1·2 to 2·3  $\mu$  diam.; the spores pale violet, faintly warted, 9·2  $\mu$  diam. Possibly this may be a form of *D. radiatum*, the columella of which is sometimes inconspicuous.

*Hab.* On dead wood, twigs, etc.—Epping Forest, Essex (B.M. 2425); Boynton, Yorks (B.M. 1063); Hexham, Northumberland (B.M. 2426); Flitwick, Beds (B.M. 1310); Devon (B.M. 1308); North Wales (B.M. 2427); Scotland (B.M. 2428); Norway (B.M. 531); Sweden (B.M. 2429); Poland (Strassb. Herb.); Germany (B.M. 2430); Switzerland (B.M. 2431); Italy (B.M. 532); Portugal (B.M. 2433); Japan (B.M. 2432); Virginia (B.M. 1311); Colorado (B.M. 2434).

14. *D. roanense* Macbr. N. Am. Slime-Moulds, 104 (1899). Plasmodium? Sporangia scattered, stalked, hemispherical, depressed or discoidal, 0·8 to 1·2 mm. diam., mottled red-brown, or dark umber, with paler lines of dehiscence; sporangium-wall dehiscing irregularly or in a somewhat stellate manner, consisting of two layers, the outer cartilaginous, brown on the outer white on the inner side, more or less adhering to the membranous inner layer. Stalk rather slender, black, furrowed, 0·1 to 0·7 mm. high. Columella flat, discoidal, ochraceous-brown. Capillitium consisting of slender simple or branched colourless threads. Spores purplish-brown, spinulose, 10 to 14  $\mu$  diam.—*Chondrioderma roanense* Rex in Proc. Ac. Nat. Sci. Phil., 1893, 368. See note under *C. radiatum* Lister Mycetozoa, 84, and in Journ. Bot., xxxv. 212.

Pl. 94.—c. sporangia (Tennessee); d. capillitium and spores with fragment of sporangium-wall.

Allied to *D. radiatum*, from which it is distinguished by the discoid shape of the sporangia and the black stalks. Intermediate forms apparently connecting the two species have been gathered by Dr. Sturgis and Mr. Bethel in Colorado.

*Hab.* On dead wood.—Tennessee (B.M. slide); Orono, Maine, U.S.A. (B.M. 1596); New Hampshire (B.M. 2435).

15. *D. asteroides* Lister. Plasmodium? Sporangia scattered, hemispherical or somewhat conical, 0·6 to 0·8 mm.

high, sessile, seldom either shortly stalked or forming plasmodiocarps, purplish-brown or bright chocolate-brown, often mottled with darker spots or marked with numerous somewhat parallel darker lines radiating from near the apex to the base of the sporangium; sporangium-wall dehiscing in a stellate manner into from eight to twenty reflexed lobes, snow-white on the inner side, the outer layer brown, cartilaginous, with abundant deposits of lime on the inner side, closely connected with the membranous inner layer. Stalk stout, white, filled with lime-granules, 0.2 mm. high. Columella hemispherical, or subglobose and depressed, white or cream-coloured. Capillitium of slender simple or anastomosing colourless or purplish threads. Spores purple-brown, minutely warted, 10 to 12  $\mu$  diam. — *Chondrioderma asteroides* Lister in Journ. Bot., xl. 209, tab. 438, fig. 1, a-c (1902); Torrend Fl. Myx., 166.

Pl. 97.—*a.* sporangia (La Mortola, Italy); *b.* capillitium and spores with fragment of sporangium-wall; *c.* spore.

Closely allied to *D. radiatum* of which it is perhaps hardly more than a marked variety with dark, sessile and usually rather conical sporangia. It has been obtained twice from the Italian Riviera; Dr. Torrend has gathered it repeatedly in the neighbourhood of Lisbon, and Herr Jaap has found it near Hamburg. Gatherings made by Dr. Sturgis on Cheyenne Mt., Colorado, differ from the type only in the more globose less conical shape of the sporangia.

*Hab.* On dead bark, pine needles, etc.—La Mortola, Italy (B.M. 1971); Germany (B.M. 2437); Portugal (B.M. 2436); Colorado (B.M. 2438).

16. *D. rugosum* Macbr. N. Am. Slime-Moulds, 105 (1899). Plasmodium grey. Total height 0.7 to 1 mm. Sporangia scattered, stalked, rarely sessile, subglobose or hemispherical, 0.5 to 0.6 mm. diam., greyish-white, brown at the base, reticulated with wrinkles "which divide the wall into 25 to 30 irregularly polyhedral portions"; sporangium-wall single, papyraceous, with scanty deposits of lime in minute granules. Stalk subulate, 0.2 to 0.6 mm. high, furrowed, black. Columella clavate, about half the height of the sporangium, rugose, chalky or yellowish-white. Capillitium consisting of slender colourless or purplish threads, anastomosing and branching towards the tips. Spores violet-brown, minutely warted, 8 to 9  $\mu$  diam.—*Chondrioderma rugosum* Rex in Proc. Acad. Nat. Sci. Phil., 1893, 369; Lister Mycetozoa, 34; Petch in Ann. Perad., iv. 345.

Pl. 86.—*a.* sporangia (N. Carolina); *b.* capillitium and spores with fragment of sporangium-wall; *c.* spore.

This species appears also to be allied to *D. radiatum* as stated by Dr. Rex, but is well distinguished by the wrinkled sporangia, the black stalks, and the clavate shape of the white columellae. Since its first

discovery in North Carolina, it has been recorded from Iowa, Antigua, and Dominica; and Mr. Petch has found it several times in Ceylon.

*Hab.* On dead leaves, moss, etc.—Ceylon (B.M. 2439); North Carolina (B.M. slide); Dominica (B.M. 1693).

17. *D. lucidum* Berk. & Br. in Ann. Mag. Nat. Hist., ser. 3, vii. 380, t. xv, a, fig. 9 (1861). Plasmodium orange-yellow. Sporangia scattered, subglobose, flattened beneath, 0.8 mm. diam., usually stalked, orange or vermilion, glossy, dehiscing irregularly or by four or five lobes that become pale at margins; outer layer of sporangium-wall translucent orange-yellow, with scanty deposits of lime on the inner side, closely connected with the yellow inner layer. Stalk slender, subulate, brownish-black, 0.2 to 0.5 mm. high. Columella obconic or subglobose, often shortly stalked, rugose, white or cream-coloured, filled with lime-granules. Capillitium forming a scanty and irregular network of stout purple-brown threads, often expanded at the axils. Spores purplish-grey, closely spinulose, 13 to 15  $\mu$  diam.—*Chondrioderma lucidum* Cooke Myx. Brit., 42 (1877); Mass. Mon., 204; Lister Mycetozoa, 86, and in Journ. Bot., xxxix. 87. *C. Carmichaelianum* Mass. Mon., 202 (1892), in part.

Pl. 98.—*a.* sporangia; *b.* sporangium broken and showing the columella; *c.* capillitium and spores with fragment of sporangium-wall; *d.* spore; (North Wales).

In Berkeley's description of this species (l.c.) two localities are given, Trefriw in Carnarvonshire, and Cumberland. Examples of the former gathering are met with in Broome's collection in the British Museum (B.M. 25), under the name of "*Diderma lucidum*," and in Berkeley's collection at Kew, where it is marked "*Diderma Carmichaelianum*, ex Herb. Broome" (K. 353). The Cumberland gathering does not appear to be represented in the quoted collections. Since the first gathering in 1860, *D. lucidum* has been found in two other stations in North Wales, once near Dolgelly, and frequently in a ravine near Llanymawddwy, where it has appeared in some abundance for several years in succession on moss on wet rocks.

A remarkable specimen, apparently nearly allied to *D. lucidum*, has been gathered by Mr. Petch on bark, at Telawakelee, Ceylon, in August, 1905 (see Petch in Ann. Perad., iv. 346). It consists of about ten clustered and almost sessile sporangia, 0.6 mm. diam.; when first found they were bright yellow, but on exposure to sunlight they faded to pale yellowish-buff; their surface is smooth, but pitted with thirty to fifty shallow pits or depressions; the sporangium-wall is cartilaginous and contains abundant deposits of yellow lime granules between the outer and inner layers; beneath each of the above-mentioned pits the wall is produced on the inner side into a stout, pale yellow process filled with lime-granules; some of these processes are short, others are long and spike-like and either end freely in the cavity of the sporangium or are connected with the columella; the latter is large, pale yellow, globular or clavate, and rough with spike-like processes containing lime-granules; a very short black stalk is present in one sporangium; the capillitium is a scanty network of rather stout purple-brown threads; the spores are purplish-grey, spinulose, and

measure 14 to 16  $\mu$  diam. It is possible that the spike-like processes of the columella and inner sporangium-wall may not be an entirely normal development; irregular growths of *D. lucidum* occasionally show similar though much shorter ingrowths from the sporangium-wall associated with a columella having a lobed and rough surface. Until further gatherings have been obtained confirming the distinctive characters of the Ceylon specimen, it may be placed provisionally with *D. lucidum*.

*Hab.* On moss on wet rocks.—Trefriw, N. Wales (B.M. 25); Llany-mawddwy (B.M. 1764).

Genus 12.—**COLLODERMA** G. Lister in Journ. Bot., xlviii. 312 (1910). Sporangia usually sessile; sporangium-wall consisting of two layers; the outer gelatinous, with superficial deposits of granular refuse-matter, and possibly with additional deposits of minute lime-granules; the inner layer membranous. Capillitium a network of purplish threads without lime-knots.

This genus appears to be allied to *Diderma*, but differs in having a gelatinous outer layer to the sporangium-wall and in the deposits of lime being scanty or absent.

1. **C. oculatum** G. Lister, l.c. Plasmodium? Sporangia scattered or grouped in small clusters, sessile, rarely stalked, either subglobose, 0.5 to 0.7 mm. diam., or forming short plasmodiocarps, olive- or purplish-brown, glossy, sometimes seated on a brownish-purple hypothallus; sporangium-wall of two layers; the outer, when moist, thick, gelatinous, hyaline, more or less encrusted with yellowish-olive granular refuse-matter; the inner layer colourless, membranous, firm. Stalk, when present, short, stout, dark brown. Columella none. Capillitium branched and anastomosing to form a network of pale or dark purplish-brown threads, colourless at the extremities, arising from the flat base of the sporangium, 2 to 4  $\mu$  diam. below, becoming very slender towards the surface. Spores brownish-purple, spinulose, 11 to 13  $\mu$  diam.—*Didymium oculatum* Lippert in Verh. Zool.-Bot. Gesell. Wien, xlv. 72, t. 4 (1894).

This species was first observed by the late Christian Lippert, who described it under the name of *Didymium oculatum*. It appeared on old fir wood that had been brought from near Hallstadt, Upper Austria, and kept for some months in a moist chamber. It has since been obtained in Scotland by the Rev. W. Cran on hepatics and dead coniferous wood, near Skene, Aberdeenshire, and also by Prof. Farlow in New Hampshire. The young sporangia are at first dirty-white, then become yellow, and at length dark brown. When mature and dry the sporangium-walls are brittle and dehisce irregularly. If an unbroken sporangium be placed in water the outer gelatinous layer of the wall swells and forms a hyaline investment 0.1 to 0.2 mm. thick, completely surrounding the membranous inner layer with its enclosed mass of spores and capillitium, and the "eye-like" effect is produced

that suggested to Lippert the specific name of *oculatum*. Some of the capillitium threads in all these gatherings show an unusual structure. They consist of a hyaline sheath enclosing a darker axis; this sheath may be interrupted to form long or short bead-like segments. Other threads have the usual homogeneous appearance. In Lippert's description, mention is made of scattered deposits of minute lime-granules in the sporangium-wall. These are not present in either the Scotch or American specimens.

*Hab.* On moss and dead coniferous wood.—Skene, Aberdeen (B.M. 3193); Chocorua, New Hampshire (B.M. 3204).

Genus 13.—**PHYSARINA** von Höhnelt in Sitzungsber. Akad. Wiss. Wien, Math.-nat. Kl., cxviii. 431 (1909). Sporangia stalked, echinulate with numerous cylindrical blunt spine-like processes projecting from the surface of the sporangium-wall. Capillitium threads without lime-knots.

Closely allied to *Diderma*, from which it differs in the structure of the sporangium-wall.

1. **P. echinocephala** von Höhnelt l.c., 432, fig. 33. Plasmodium? Sporangia gregarious, stalked, subglobose, 0.4 to 0.5 mm. diam., pale pink or flesh-coloured; sporangium-wall of two layers, the outer layer somewhat cartilaginous, enclosing lime-granules and produced into numerous (60 to 100) blunt-ended cylindrical processes, 25 to 40  $\mu$  wide, and 80  $\mu$  long, filled with lime-granules; the inner layer smooth, membranous, more or less adhering to the outer. Stalk stout, conical, furrowed, flesh-coloured or nearly white, 0.1 to 0.4 mm. high, filled with lime-granules, continued above into a pale subglobose or hemispherical columella. Capillitium-threads violet-brown, paler and branching at the extremities. Spores nearly smooth, brownish-violet, 7 to 9  $\mu$  diam.

Pl. 198.—*a.* sporangia; *b.* capillitium and spores, with a fragment of sporangium-wall showing one of the spine-like prominences; *c.* spore; (Java).

This remarkable species has hitherto been recorded only from Java, where it has been gathered by both Prof. R. Ernst and Prof. F.v. Höhnelt. The latter describes the colour of the sporangia as blackish chocolate-brown, but the sporangia received from him, and those of Prof. Ernst's gathering in the Zürich Herbarium, are pale flesh-coloured.

*Hab.* On dead leaves.—Java (B.M. 2440).

Genus 14.—**DIACHAEA** Fries Syst. Orb. Veg., i. 143 (1825). Sporangium-wall hyaline, iridescent, without deposits of lime. Walls of stalk and columella membranous, charged with lime in the form of granules or crystalline nodules, sometimes without lime. Capillitium a profuse network of purplish threads, without lime-knots.

This genus forms a connecting link between the *Calcarineae* and the *Stemonitaceae*. The limeless forms closely resemble some species of *Lamproderma*, but are distinguished by having the walls of the columella and stalk membranous.

KEY TO THE SPECIES OF *DIACHAEA*.

## A. Sporangia globose :—

## A. Lime in stalk white.

Spores with dark raised bands and tubercles.

3. *D. splendens*

Spores spinulose.

2. *D. bulbillosa*

Spores delicately reticulated.

4. *D. subsessilis*

## B. Lime in stalk orange.

5. *D. Thomasii*B. Sporangia cylindrical (globose in *D. leucopoda* var. *globosa*).

Spores nearly smooth ; lime in stalk white.

1. *D. leucopoda*

Spores delicately reticulated ; lime absent in the two recorded gatherings.

6. *D. cylindrica*

Spores warted ; lime absent.

7. *D. caespitosa*

1. *D. leucopoda* Rost. Mon., p. 190, fig. 178 (1875). Plasmodium opaque white. Sporangia gregarious, cylindrical, obtuse, stalked, 0·7 mm. high by 0·25 mm. broad, iridescent purple ; sporangium-wall membranous, hyaline. Stalk white, stout, brittle, furrowed, one-third or one-half the height of the sporangium, broad at the base, rising from a well developed hypothallus, densely charged with round lime-granules 2 to 4  $\mu$  diam. Columella cylindrical or narrowed upwards, reaching half-way or nearly to the apex of the sporangium, white, densely charged with lime in the form of granules, sometimes in the form of crystalline nodules. Capillitium consisting of profusely branched and anastomosing threads connecting the columella with the sporangium-wall, dark violet-brown, colourless at the extremities. Spores dull violet, minutely spinulose, 7 to 9  $\mu$  diam. — Mass. Mon., 259 ; Macbr. N. Am. Slime-Moulds, 134. *Trichia leucopodia* Bull. Champ., p. 121, t. 502, fig. 2 (1791). *Stemonitis elegans* Trentep. in Roth Catal. Bot., i. 220 (1797). *S. leucostyla* Pers. Syn., 186 (1801). *S. leucopodia* DC. Fl. Fr., ii. 257 (1805). *Diachaea elegans* Fr. Syst. Orb. Veg., i. 143 (1825) ; Lister Mycetoza, 91. *D. confusa* Mass. Mon., 259 (1892).

Var. *globosa* Lister : sporangia globose.

Pl. 99.—a. sporangia (England) ; b. capillitium and spores ; c. spore.

This abundant and widely distributed species often forms large plasmodia that produce many hundred sporangia. The type of *D. confusa* Mass. from Jamaica is a form of *D. leucopoda* ; the spores measure 7 to 8  $\mu$ , and are not "clustered" but free, except where they are



combined in masses by mould; the lime in the stalk and columella is in the form of crystalline nodules instead of lime granules, but this modification occurs not infrequently in otherwise normal growths of *D. leucopoda*. The var. *globosa* is apparently rare; it has been obtained in New Hampshire, U.S.A., in Chili, Japan and in Java.

*Hab.* On dead leaves, sticks, etc.—Wanstead, Essex (B.M. 1318); Lyme Regis (B.M. 2442); Stafford (B.M. 2444); near Paris (B.M. 2445); Germany (B.M. 580); Poland (Strassb. Herb.); Sweden (B.M. 2446); Bohemia (B.M. 584); Austria (B.M. 1818); Italy (B.M. 1946); Portugal (B.M. 2447); Central Africa (B.M. 1163); Nigeria (B.M. 2443); Natal (K. 433); S. India (B.M. 590); Ceylon (B.M. 591); Java (Herb. Dr. Jahn, Berlin); Melbourne, Australia (B.M. 2449); New Zealand (B.M. 2448); Japan (B.M. 1999); Colorado (B.M. 2450); Ohio (B.M. 1319); New Jersey (B.M. 1842); Ontario (B.M. 2452); Cuba (K. 438); Jamaica (Herb. Masee); Antigua (B.M. 2451); Ecuador (B.M. 2453); Chili (B.M. 2350); Paraguay (Paris Herb.).

2. *D. bulbillosa* Lister in litt., ex Penzig Myx. Buit., 47 (1898). Plasmodium? Sporangia gregarious, globose, stalked, 0.3 to 0.45 mm. diam., shining iridescent purple; sporangium-wall membranous, colourless. Stalk conical, 0.3 to 0.5 mm. high, expanded at the base, either white throughout and filled with lime-granules, or brown and more slender above, and containing lime in the form of crystalline nodules. Columella clavate, white or brown, containing lime in the form of minute granules or in nodules, or entirely without lime. Capillitium a rather lax network of purple-brown threads, spreading from the columella to the sporangium-wall. Spores violet-grey, marked with scattered warts (from six to eight in a row across the hemisphere), 7 to 9  $\mu$  diam.—Lister in Journ. Bot., xxxvi. 165, tab. 386, fig. 10 (1898); Petch in Ann. Perad., iv. 315, 347. *Didymium bulbillosum* Berk. & Br. in Journ. Linn. Soc., xiv. 84 (1873). *Diachaea splendens* Racib. in Hedw., xxxvii. 54 (*non* Peck). *Diachaeella bulbillosa* v. Höhnelt in Sitzungsber. k. Akad. Wiss. Wien, Math.-nat. Kl., cxviii. 437, fig. 34 (1909).

Pl. 99.—*g.* spores (Java); *h.* spore, highly magnified.

This species is closely allied to the globose form of *D. leucopoda*, but differs in having the spores marked with strong scattered warts. Since the first gathering was made by Thwaites in Ceylon, in 1867, *D. bulbillosa* has again been found abundantly in that island, by Mr. Petch, on dead leaves. Prof. Penzig records this as being a common species in Java. It has been made the type of a new genus, *Diachaeella*, by Prof. v. Höhnelt on account of the nodular character of the lime in the stalk and columella, but this feature is by no means constant, and may occur also in *D. leucopoda* and *D. subsessilis*.

*Hab.* On dead leaves, twigs, etc.—Ceylon (B.M. 592); Java (B.M. 1707).

3. *D. splendens* Peck in Rep. N. York Mus. Nat. Hist., xxx. 50 (1878). Sporangia metallic blue; otherwise similar to the globose form of *D. leucopoda*, except that the spores are marked with dark raised bands and tubercles.—Mass. Mon., 261; Macbride N. Am. Slime-Moulds, 135.

Pl. 99.—*d.* sporangia (New York); *e.* capillitium and spores; *f.* spores.

*Hab.* On dead leaves, sticks, etc.—Philadelphia (B.M. 1320); New Haven, Conn. (B.M. 1321); Iowa (B.M. 1322).

4. *D. subsessilis* Peck in Rep. N. York Mus. Nat. Hist., xxxi. 41 (1879). Plasmodium yellow. Sporangia gregarious, globose, 0.5 mm. diam., stalked, rarely sessile and forming short plasmodiocarps, shining iridescent-purple or bronze; sporangium-wall membranous, colourless. Stalk stout, conical, white and filled either with lime-granules or crystalline nodules of lime, or brown and without lime, 0.2 to 0.5 mm. high. Columella conical, white, yellowish or brown, rarely obsolete. Capillitium radiating from the columella and consisting of branched and anastomosing purple-brown threads, usually stouter and paler below, slender and colourless at the tips. Spore-walls purplish-grey with yellow contents giving a purplish-green effect, reticulated with rows of close-set minute warts, forming a net with about six meshes across the hemisphere, 7 to 10  $\mu$ .—Mass. Mon., 262; Rex in Proc. Acad. Nat. Sci. Phil., 1893, 368; Burrell in Trans. Norf. Nat. Soc., vi. 449, plate; Petch in Ann. R. Bot. Gard. Perad., iv. 347.

Pl. 100.—*a.* sporangia with white stalks (Bedfordshire); *b.* sporangia with short black stalks, and sessile sporangia; *c.* capillitium and spores; *d.* spore.

This species has now been obtained from many parts of the world. Sporangia with limeless stalks, dark from enclosed refuse matter, are often found associated with others having the stalks white and containing lime-granules only. When the limeless form occurs alone it resembles a *Lamproderma* externally, but may at once be distinguished by the membranous stalk and columella. Through the courtesy of Dr. Čelakovský we have seen a glycerine preparation of *Lamproderma Fuckelianum* Rost. var. *cracowense* Racib.; it appears to be a form of the present species without lime in the membranous columella and short stalk; the spores are purplish-grey, empty of protoplasmic contents, and are closely reticulated with delicate raised lines. The type of *L. Fuckelianum* Rost. (Mon., p. 208, t. xiii, fig. 6) is not represented in the quoted collections, but Rostafinski's illustration exactly represents the black-stalked limeless form of *D. subsessilis*; in the absence of the type of *L. Fuckelianum* however, it would seem better to retain Peck's specific name although it is of later date.

*Hab.* On dead leaves and twigs.—Flitwick, Beds (B.M. 1705); Holt, Norfolk (B.M. 1706); Pitlochrie, N.B. (B.M. 2457); near Paris (B.M. 2454); N. Germany (B.M. 2455); Ceylon (B.M. 2456); Antigua (B.M. slide); Poquonnoek, Conn. (B.M. 2458).

5. *D. Thomasii* Rex in Proc. Acad. Nat. Sci. Phil., 1892, 329. Plasmodium rich yellow. Sporangia globose, shortly stalked or sessile, scattered or crowded on a common orange hypothallus, 0.6 to 0.7 mm. diam., iridescent, copper-coloured or violet-blue; sporangium-wall membranous, hyaline. Stalk short, stout, rich orange, densely charged with orange lime-granules, continued above into the conical or shortly cylindrical columella. Capillitium radiating from all parts of the columella, composed of rather rigid violet-brown threads, branching and anastomosing, tapering to the hyaline extremities. Spores grey with yellow contents resulting in an olive-coloured effect, marked with small scattered warts, and four to eight prominences, each of which a high magnifying power resolves into a compact cluster of minute warts, 9 to 11  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 136.

Pl. 101.—*a.* sporangia; *b.* capillitium and spores; *c.* spore; (N. Carolina).

*Hab.* On dead bark and moss.—Cranberry, North Carolina (B.M. 1323); Tennessee (B.M. 2459).

6. *D. cylindrica* Bilgram in Proc. Acad. Nat. Sci. Phil., 1905, 524. Plasmodium? Sporangia gregarious or clustered, cylindrical, sessile, 1 to 1.7 mm. high, 0.5 to 0.65 mm. thick, shining iridescent-bronze or steel-grey; sporangium-wall membranous, colourless, at length breaking away in large flakes. Columella pale brown, membranous, slender, extending nearly to the apex of the sporangium, or discontinuous and breaking up into irregular branching strands. Capillitium consisting of branched and anastomosing purplish-brown threads, spreading from all parts of the columella, slender and colourless at the tips. Spores purplish-grey, 11 to 12  $\mu$  diam., reticulated as in *D. subsessilis* with rows of minute spines.

Pl. 103.—*a.* sporangia (Philadelphia); *b.* sporangium after dispersion of spores; *c.* capillitium and spores; *d.* *e.* spores.

This species was first gathered by Dr. Rackstraw, in Fairmount Park, Philadelphia; several years later it was found again at a spot about nine miles distant, by Mr. Hugo Bilgram. It closely resembles *D. caespitosa*, from which it differs in having reticulated spores.

*Hab.* On dead leaves and twigs.—Philadelphia (B.M. 2460).

7. *D. caespitosa* Lister in Journ. Bot., xlv. 186 (1907). Plasmodium? Sporangia in clusters of six to twenty, cylindrical or clavate-cylindrical, sessile or shortly stalked, 0.7 to 1.5 mm. high, 0.5 mm. thick, iridescent blue or bronze; sporangium-wall membranous, colourless, soon breaking away above, more persistent below. Stalk slender, dark brown, 0.1 mm. high, not enclosing lime-granules, arising from a yellowish membranous hypothallus. Columella a slender, membranous wrinkled tube, brown below, yellowish above, reaching to

nearly the apex of the sporangium. Capillitium a network of purple-brown threads spreading from all parts of the columella. Spores with pale purplish-grey walls enclosing yellow or colourless contents, marked with small scattered warts, and several clusters of rather stronger warts, 9 to 11  $\mu$ .—*Comatricha caespitosa* Sturgis in Bot. Gaz., xviii. 186, t. xx, figs. 1 to 4 (1893); Macbr. N. Am. Slime-Moulds, 124. *Diachaea Thomasii* Rex, var. ? Lister Mycetozoa, 92 (1894).

Fig. 103.—*f.* sporangia; *g.* sporangium after dispersion of spores; *h.* capillitium and spores; *i. j.* spores; (Woods Holl, Mass.).

This species was placed by Dr. Sturgis in the genus *Comatricha*; its affinities however would seem to be rather with *Diachaea* on account of the membranous although limeless character of the stalk and columella. It is closely allied to *D. cylindrica* (q.v.). *D. caespitosa* has been recorded hitherto only from the Eastern United States; it has been gathered at Kittery, Mne. by Prof. Thaxter, at Woods Holl, Mass. by Mr. M. B. M. Davis, and in North Carolina (*sic* Prof. Macbride).

*Hab.* On moss.—Woods Holl, Mass. (B.M. 1324).

## ORDER II.—DIDYMIACEAE.

Deposits of lime in the form of crystals or crystalline discs distributed over the sporangium-wall; capillitium without lime-knots; sporangia simple, except in *Mucilago*, where they are combined into an aethalium.

### KEY TO THE GENERA OF DIDYMIACEAE.

Lime-crystals stellate; sporangia single. (15) DIDYMIUM.

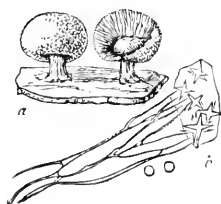


Fig. 23.

Fig. 23.—*Didymium squamulosum* Fr.

- a. Two sporangia, one entire, the other showing columella and capillitium. Magnified 12 times.
- b. Capillitium and fragment of sporangium-wall, with crystals of calcium carbonate and two spores. Magnified 200 times.

Lime-crystals stellate, heaped together, at first concealing the confluent sporangia. (16) MUCILAGO.



Fig. 24.

Fig. 24.—*Mucilago spongiosa* Morg.

- a. Aethalium. Natural size.
- b. Capillitium and fragment of sporangium-wall, with crystals of calcium carbonate and two spores. Magnified 200 times.

Lime-crystals more or less lenticular and marked with radiating striae, scattered over the sporangium-wall.

(17) *LEPIDODERMA*.

Fig. 25.—*Lepidoderma tigrinum* Rost.

a. Sporangium. Magnified 6 times.

b. Capillitium and spores. Magnified 140 times.

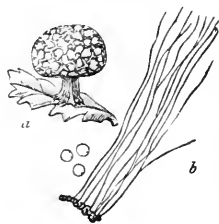


Fig. 25.

Genus 15.—*DIDYMIUM* Schrader *Nov. Gen. Plant.*, 20 (1797). Sporangia stalked, sessile, or forming plasmodiocarps, not united into an aethalium; sporangium-wall membranous or cartilaginous, beset with superficial crystals of lime either scattered over the surface or combined into a separable crust; capillitium of branching threads, which are often thickened at intervals with dark calyciform nodes, without lime-knots.

The subgenus *Lepidodermopsis* forms a connecting link between the true *Didymia* and the genus *Lepidoderma*, having the superficial stellate crystals of the former, and the cartilaginous sporangium-wall of the latter.

KEY TO THE SPECIES OF *DIDYMIUM*.

Subgenus 1. — *EUDIDYMIUM*. Sporangium-wall membranous.

A. Superficial crystals closely combined to form a thin egg-shell-like crust :—

Sporangia sessile, pulvinate; capillitium threads scanty, broad at the base or profuse and slender throughout; spores usually smooth.

1. *D. difforme*

Sporangia sessile, pulvinate; capillitium a network of stout purple threads; spores rough.

2. *D. quitense*

Sporangia sessile, flat; capillitium rigid, dark, profuse, slender at the points of attachment.

3. *D. dubium*

Sporangia turbinate, shortly stalked or sessile; capillitium rigid, usually colourless. 4. *D. Trochus*

B. Superficial crystals scattered or loosely combined :—

A. Plasmodiocarps; capillitium associated with large olive-coloured vesicles.

5. *D. complanatum*

B. Sporangia stalked or forming plasmodiocarps; capillitium without vesicles; spores more or less spinulose—

a. Sporangia disc-shaped, with dark stalks.

6. *D. Clavus*

b. Sporangia subglobose or effused—

Stalk and columella dark brown; stalk opaque and granular. 7. *D. melanospermum*

Stalk olive-brown or orange, translucent, not granular. 8. *D. nigripes*

Stalk and columella white or yellowish; crystals on sporangium-wall scattered or forming a wrinkled crust; sporangia often forming plasmodiocarps, dehiscing irregularly. 9. *D. squamulosum*

Sporangia forming slender plasmodiocarps with scanty lime deposits, dehiscing in a circumscissile manner; columella none. 10. *D. anellus*

Sporangia forming large pulvinate plasmodiocarps, 1 to 25 mm. long, dehiscing irregularly; columella none; capillitium forming an abundant elastic network. 11. *D. Wilczekii*

Stalk short, membranous, pale buff; crystals on sporangium-wall forming a smooth, thick, deciduous envelope. 13. *D. crustaceum*

c. Sporangia with orange stalks; sporangium-wall hyaline; spores dark brown, closely reticulated.

12. *D. intermedium*

Subgenus 2.—LEPIDODERMOPSIS. Sporangium-wall cartilaginous.

Stalk and columella orange or orange-brown; sporangium-wall areolated, orange-brown.

14. *D. leoninum*

1. *D. difforme* Duby Bot. Gall., ii. 858 (1830). Plasmodium colourless or yellow. Sporangia scattered, pulvinate on a broad base or forming irregularly elongated plasmodiocarps, 0.4 to 2 mm. or more long, smooth, white; sporangium-wall of two layers, the outer a thin eggshell-like crust of densely combined minute crystals of lime, separating from the iridescent membranous inner layer, which is purplish or colourless above, stout and yellowish-brown at the base and thickened at the margin. Columella none. Capillitium scanty, consisting of coarse or slender purple or colourless flattened threads, usually broad at the base, branching dichotomously and slender above. Spores dark purple-brown, usually faintly and closely warted, sometimes marked with

stronger scattered warts, 11 to 14  $\mu$  diam.—Torrend Fl. Myx., 149; Petch in Ann. Perad., iv. 348. *Diderma difforme* Pers. Disp. Meth., 9 (1797). *D. cyanescens* Fr. Syst. Myk., iii. 109 (1829). *D. liceoides* Fr. l.c., 107? *D. nitens* Klotzsch in Sm. Engl. Fl., v. pt. 2, 311 (1836). *D. chalybeum* Weinm. Hymen. & Gast., 592 (1836). *D. Libertianum* Fres. Beitr. Myk., 28, tab. iv. figs. 16 to 27 (1850). *D. Persoonii* Macbr. N. Am. Slime-Moulds, 96 (1899). *Licea caesia* Schum. Enum. Pl. Saell., ii. p. 219 (1803). *L. alba* Nees in Kunze & Schmidt Myc., ii. 66 (1823). *L. macrospora* Schwein. in Trans. Am. Phil. Soc., n.s. iv. 258 (1832). *Didymium cyanescens* Fr. Symb. Gast., 19 (1817). *D. Libertianum* de Bary Mycetozoa, 124 (1864). *Physarum album* Fr. Syst. Myc., iii. 147. *P. caesium* Fr. l.c. *Lycogala minutum* Grev. Scot. Crypt. Fl., t. 40 (1823). *Chondrioderma difforme* Rost. in Fuckel Symb. Myc., Nachtr., 73 (1873), & Mon., 177; Lister in Ann. Bot., iv. 281; Mass. Mon., 212. *C. liceoides* Rost. l.c., App. p. 17 (1876); Mass. l.c., 215.

**Var. comatum** Lister in Journ. Bot., xxxix. 8. Capillitium profuse, of slender straight branching threads, not thicker below, dark or colourless.—*Leocarpus calcareus* Link in Mag. Ges. Nat. Fr. Berl., iii. 26 (1809)? *Chondrioderma calcareum* Rost. in Fuckel Symb. Myc., Nachtr., 74 (1873)?

Pl. 104.—*a.* sporangia (Lyme Regis); *b.* capillitium and spores, with a fragment of the upper and lower sporangium-wall; *c.* capillitium and spores of var. *comatum*; *d.* spore of type.

This species is here removed from *Chondrioderma* (syn. *Diderma*) where it was placed by Rostafinski, on account of the crystalline character of the lime forming the outer crust of the sporangium-wall. The type of *Licea macrospora* Schwein. from Carolina (K. 1206), named *Chondrioderma liceoides* by Rostafinski, is a characteristic specimen of the present species. The var. *comatum* has appeared abundantly throughout the winter months for several years in the neighbourhood of Lyme Regis: it has also been obtained from Bedfordshire and Cornwall, from Japan and Philadelphia. Besides being characterised by having profuse capillitium, the plasmodiocarps are often larger and more plate-like, and the spores greyer than in the typical form, but these characters are not constant. There is no type of *Chondrioderma calcareum* Rost. in the quoted collections; the description in Rostafinski's monograph, however, applies so well to the var. *comatum* of *D. difforme* that there can be little doubt it refers to this form.\*

**Hab.** On dead leaves and herbaceous stems. Very common in the British Isles.—Wanstead, Essex (B.M. 1325); Lyme Regis, Dorset (B.M. 1326); Welshpool, Wales (B.M. 1062); France (K. 386); Germany (B.M. 507); Belgium (K. 401); Switzerland (B.M. 1975); Austria (B.M. 1815); Italy (B.M. 527); Portugal (B.M. 2461); India (K. 1466); Seychelles (K. 1467); Japan (B.M. 2462); Philadelphia (B.M. 2463); Carolina (K. 1206).

\* The description of *C. calcareum* Rost. in Saccardo's Sylloge, vii. 370, is contracted, and omits any reference to the abundant development of the capillitium.

2. *D. quitense* Torrend Fl. Myx., p. 150 (1909). Plasmodium? Sporangia scattered, sessile, hemispherical, depressed, 0.4 to 0.5 mm. diam., smooth, white; outer sporangium-wall white, egg-shell-like, separating from the membranous, pale purplish inner wall. Columella none. Capillitium a network of rather stout purplish-brown flexuose threads, equal in thickness throughout. Spores brownish-purple, 13 to 14  $\mu$  diam., marked with warts and minute V-shaped ridges more or less united to form an imperfect reticulation.—*Chondrioderma quitense* Pat. in Bull. Soc. Myc. Fr., xi. 212 (1895)?

Closely allied to *D. difforme* from which it differs in the flexuose network of the capillitium and in the spores being marked with an imperfect reticulation.

*Hab.* On dead leaves.—Ecuador (B.M. slide).

3. *D. dubium* Rost. Mon., p. 152 (1875). Plasmodium watery white. Sporangia solitary, forming rounded or irregular almost flat plasmodiocarps, 1 to 12 mm. broad, 0.13 mm. thick; sporangium-wall of two layers, the outer consisting of an eggshell-like crust of closely combined large stellate crystals, often extending beyond the broad membranous base of the sporangium, and powdered with free crystals, the inner layer membranous. Columella none. Capillitium profuse, consisting of rigid, dark purplish-brown threads, anastomosing chiefly above and below and attached at either end by colourless slender branches to the sporangium-wall. Spores violet-grey, spinulose or nearly smooth, 8 to 15  $\mu$  diam.—Mass. Mon., 246. *Didymium Listeri* Mass. l.c., 244.

Pl. 105.—*a.* sporangia (Lyme Regis); *b. c.* various forms of capillitium and spores, with crystals from the sporangium-wall; *d.* capillitium and spores of the type specimen from Hauenstein, Bohemia; *e.* spore.

This species may be distinguished in the field from *D. difforme* by the eggshell-like crust being powdered or mealy with loose crystals, while that of *D. difforme* is quite smooth and almost glossy. *D. dubium* is abundant in the neighbourhood of Lyme Regis, where it presents considerable variation. In many gatherings the spores are nearly smooth, measuring 8 to 10  $\mu$  diam., in others spinulose, 12 to 15  $\mu$  diam.; the capillitium may differ from the usual form in being flexuose with bead-like or irregular thickenings and in having short free branches. Specimens submitted to Rostafinski are pronounced by him to differ from the original Hauenstein gathering in having smoother spores and more slender capillitium without thickenings; considering the variation mentioned above, these characters cannot be accepted as sufficient to mark the Lyme Regis form as a distinct species. This view is confirmed by inspection of part of the type itself, which has kindly been presented to us by Dr. Celakovsky, jun.

*Hab.* On rotting leaves, especially on those of ivy and holly.—Lyme Regis, Dorset (B.M. 1327); Bohemia (B.M. 2464).



4. **D. Trochus** Lister in Journ. Bot., xxxvi. 164, tab. 386, fig. 1, a to c (1898). Plasmodium bright "buttercup" yellow. Sporangia scattered, hemispherical or top-shaped, 0.6 to 1 mm. diam., shortly stalked or sessile, rarely forming plasmodiocarps, smooth, cream-coloured or white; sporangium-wall readily falling off entire and consisting of two layers; the outer layer brittle and shell-like, composed of closely compacted, angular or stellate crystals of lime forming a hemispherical cap fitting on to the yellow-brown thickened margin of the broad convex columella; the inner layer membranous, usually adhering to the outer layer. Stalk obconical or shortly cylindrical, yellowish-brown, 0.2 to 0.4 mm. high, filled like the columella with stellate crystals of lime. Capillitium consisting of rigid and persistent colourless or purplish-brown nearly simple or branched threads, sometimes expanded below into membranous vesicles filled with lime-crystals. Spores brownish-purple, 9 to 10  $\mu$  diam., strongly warted, paler and the warts smaller on one side of the spore than on the other.—Torrend Fl. Myx., 150.

Pl. 106.—*a.* sporangia (Bedfordshire); *b.* capillitium and spores with fragments of the crystalline outer layer of the sporangium-wall and of the columella; *c.* spore.

This species has been recorded from three English counties, Beds, Bucks and Surrey, and also from Portugal, where Dr. Torrend has found it on decaying leaves of *Agave*. In this country it has been found some years in great profusion on old straw-heaps among the deeper layers of the straw. To collect perfect specimens may require a little care, as the shell-like sporangium-walls and often the sporangia themselves are easily detached. *D. Trochus* differs from *D. difforme*, its nearest ally, in the sporangia being usually provided with a stalk, in the presence of a prominent columella, and in the warted spores.

*Hab.* On dead leaves and old straw.—Kitchen End, Beds (B.M. 1708); Reigate, Surrey (B.M. 2465); Portugal (B.M. 2466).

5. **D. complanatum** Rost. Mon., p. 151 (1875) (*non* Schrad.). Plasmodium lemon-yellow. Sporangia forming scattered or solitary depressed plasmodiocarps, 2 to 8 mm. broad, 0.1 to 0.15 mm. thick, either effused, perforated and net-like, or vermiform, grey; sporangium-wall membranous, colourless, with scattered superficial stellate crystals of lime. Columella none. Capillitium consisting of very slender somewhat branching and anastomosing pale violet threads, connected with numerous subglobose vesicles 20 to 50  $\mu$  diam. filled with yellow obscurely granular matter. Spores pale violet-brown, minutely warted, 7 to 9  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 85. *Lycoperdon complanatum* Batsch Elench. Fung., i. 251 (1786)? *Physarum confluens* Pers.  $\beta$  *muscigenum* Alb. & Schw. Consp. Fung., 61 (1805)? *Didymium Serpula* Fr. Syst. Myc., iii. 126 (1829)?; Rost. Mon., App. p. 21; Lister Mycetozoa, 96.

Pl. 107.—*a.* plasmodiocarp (England); *b.* section of plasmodiocarp showing capillitium with large vesicles; *c.* capillitium and spores; *d.* spore.

No writers before Rostafinski make any mention of the characteristic vesicles of the capillitium, and the references to Batsch and Fries quoted above might apply as well to plasmodiocarp forms of *D. squamulosum* which *D. complanatum* often superficially resembles. The reference by Albertini & Schweinitz to the yellow plasmodium of *Physarum confluens*  $\beta$  *muscigenum* (l.c.) makes it probable that they were describing the present species in part at least. The drawing of the capillitium in Mr. Masee's Monograph (fig. 56) of *D. complanatum* does not represent the characteristic vesicles, and the specimens from Kew, Batheaston, and Carlisle in his collection quoted by him under this name (l.c. 234) are plasmodiocarp forms of *D. squamulosum*. These vesicles are frequently traversed by the capillitium threads, and are apparently formed later than the capillitium; like the spores, they are minutely warted.

*Hab.* On dead leaves.—Lyne Regis, Dorset (B.M. 2467); Flitwick, Beds (B.M. 2468); Lynton, Devon (B.M. 1328); North Wales (B.M. 2469); France (B.M. 2472); Germany (B.M. 1329); Portugal (B.M. 2471); Switzerland (B.M. 2470); Philadelphia (B.M. 1330).

**6. *D. Clavus*** Rost. Mon., p. 153 (1875). Plasmodium grey or colourless. Total height 0.4 to 0.8 mm. Sporangia scattered, disc-shaped, stalked, erect, 0.7 to 1 mm. diam., 0.2 mm. thick, greyish-white; sporangium-wall membranous, more or less spotted with reddish-brown and beset with superficial clusters of stellate crystals of lime above, thickened and brown at the base. Stalk cylindrical, longitudinally striate, pale brown or black. Columella none, or represented only by the thickened base of the sporangium-wall. Capillitium profuse, consisting of sparingly branched colourless or purple-brown threads. Spores pale violet-brown, almost smooth, 5 to 8  $\mu$  diam.—Mass. Mon., 230; Macbr. N. Am. Slime-Moulds, 90. *Physarum Clavus* Alb. & Schw. Consp. Fung., 96 (1805). *Reticularia hemispherica* Bull. Champ., p. 93, pl. 446, fig. 1, in part? *Didymium melanopus*  $\beta$  *Clavus* Fr. Syst. Myc., iii. 114 (1829). *D. hemisphericum* Fr. l.c., 115, in part? *D. commutabile* Berk. & Br. in Journ. Linn. Soc., xiv. 83 (1873); Rost. Mon., App. p. 21. *D. radiatum* Mass. l.c., 229 (1892), in part. *D. neglectum* Mass. (non Berk. & Br.) l.c., 231. *D. Maseeanum* Sacc. & Syd. Syll. Fung., xiv. 836 (1899).

PL. 108.—*a. b.* sporangia (England); *c.* capillitium and spores with fragments of the upper and lower sporangium-walls; *d.* spore.

The characters of the type of *D. commutabile* Berk. & Br. from Ceylon (B.M. 537) agree in all respects with those of the present species, except that the stalk is 1.5 mm. long, and is encrusted with deposits of lime. The type of *D. neglectum* Mass., from Philadelphia, growing with *Physarella oblonga*, in Herb. Masee, is a slender form of *D. Clavus*; all the sporangia have the upper wall broken and the spores shed, but sufficient remains to indicate the discoid form; the sporangium-wall is faintly mottled with brown; the capillitium is slender, the spores pale violet-brown, 5 to 6  $\mu$  diam.

*Hab.* On dead leaves, twigs, etc. Common.—Batheaston, Somerset (B.M. 80); Epping Forest, Essex (B.M. 1331); Lyme Regis (B.M. 1332); near Aberdeen (B.M. 2473); Germany (Strassb. Herb.); Portugal (B.M. 2474); Ceylon (B.M. 537); Java (B.M. 2475); Philippine Islands (B.M. 2035); New York (B.M. 1881); Philadelphia (B.M. slide); Antigua (B.M. 1664).

**7. *D. melanospermum* Macbr.** N. Am. Slime-Moulds, 88 (1899). Plasmodium colourless or grey. Total height 0.5 to 1 mm. Sporangia gregarious, subglobose or hemispherical, deeply umbilicate beneath, 0.7 to 1 mm. diam., either stalked or sessile, often confluent, white or grey; sporangium-wall firm, mottled with purple-brown and beset with stellate crystals of lime. Stalk cylindrical from a broad base, striate, dark brown, rarely rufous, 0.2 to 0.7 mm. long, 0.05 to 0.2 mm. thick, opaque and granular from enclosed refuse matter, sometimes containing crystalline nodules of lime. Columella large, hemispherical, umbilicate, dark brown, rarely whitish, chambered, containing irregular nodules of lime. Capillitium of stout sparingly branched or simple more or less flexuose threads, colourless or purplish-brown, often showing dark calyciform thickenings. Spores dark purplish-brown or purplish-grey, with a thick spore-wall, nearly smooth or spinose, 9 to 12  $\mu$  diam.—*Physarum melanospermum* Pers. in Roemer N. Mag. Bot., 88 (1794). *P. farinaceum* Pers. Syn., 174 (1801). *P. cinerascens* Schum. Enum. Pl. Saell., ii. 199 (1803) ? *P. globosum* Schum. l.c., 203 ? *P. sinuosum* Link in Mag. Ges. Nat. Fr. Berl., iii. 27 (1809). *P. capitatum* Link l.c. *P. nigrum* Fr. Syst. Myc., iii. 146 (1829) ? *Didymium farinaceum* Schrad. Nov. Gen. Pl., 26, t. 5, fig. 6 (1797); Rost. Mon., p. 154; Mass. Mon., 219; Lister Mycetozoa, 97. *D. complanatum* Schrad l.c., 24, t. 5, fig. 5 ? *D. lobatum* Nees Syst., 112 (1816) ?; Fr. Syst. Myc., iii. 123. *D. physaroides* Fr. Symb. Gast., 21 (1818); Rost. Mon., p. 158; Mass. l.c., 233. *D. melanopus* Fr. Syst. Myc. iii. 114 ? *D. Fairmani* Sacc. Journ. Myc., 1889, 79, & Fairman Contr. Myc. West N.Y., 52, t. iii., figs. 7 to 9. *Trichia compressa* Trentep. in Roth Catal. Bot., i. 229 (1797). *T. farinosa* Poir. in Lam. Encycl., viii. 53 (1799). *T. sphaerocephala* Sow. Engl. Fung., t. 240 (1799). *Spumaria physaroides* Pers. Syn. Fung., 163 (1801) ? *Strongylium minus* Fr. Symb. Gast., 9 (1817).

Var. *minus* Lister: threads of capillitium slender; spores 7 to 9  $\mu$  diam.—*D. humile* Hazsl. in Oester. Bot. Zeitschr., xxvii. 84 (1877). *D. minus* Morg. in Myx. Miami Valley 61, 1894; Macbr. l.c., 89.

Pl. 112.—*a.* sporangia (England); *b.* capillitium and spores with fragment of sporangium-wall; *c.* spore; *d.* sporangia of var. *minus* (England); *e.* capillitium and spores of same; *f.* spore.

Intermediate forms uniting the var. *minus* and the typical form are so frequent that the former cannot be regarded as a distinct species;

it is, however, very constant in its characters from different parts of the world, being distinguished by the smaller sporangia and more slender capillitium; it often bears a considerable resemblance to *D. nigripes*, and is named "*D. microcarpum*" Rost. (a synonym for *D. nigripes*) in some specimens in Strassb. Herb.; the opaque granular stalk distinguishes it from that species and its allies. Forms sometimes occur with the upper part of the stalk as well as the columella pale brown and filled with crystalline nodules of lime. Rostafinski's specimen of *D. physaroides* in the Strassb. Herb. appears to be an imperfect development of *D. melanospermum*; the spores, many of which are abnormal in shape and size, 15 to 50  $\mu$  long, are combined in agglutinated masses, and the capillitium contains vesicular expansions filled with lime such as are not unfrequent in imperfect growths of *Didymium*; the sporangia are mostly clustered and confluent, but in some cases they are solitary; the columella is dark brown and chambered, and the sporangium-wall is mottled with purple-brown.

*Hab.* On dead wood, twigs and leaves, especially of Conifers. Common.—Highgate, London (B.M. 1068); Lyme Regis, Dorset (B.M. 1333); Ascot, Berks (B.M. 70); North Wales (B.M. 2476); near Aberdeen (B.M. 2477); France (B.M. 1977); Germany (B.M. 422); Zürich (B.M. 1560); Portugal (B.M. 2478); Bohemia (Herb. Čelakovsky); Mt. Ruwenzori, Africa (B.M. 1164); New Zealand (B.M. 2485); Maine, U.S.A. (B.M. 1603); Georgia (B.M. 2480); South Carolina (B.M. 889): var. *minus*—Lyme Regis (B.M. 1334); France (B.M. 2481); Portugal (B.M. 2486); Nigeria (B.M. 2482); Java (B.M. 2483); Antigua (B.M. 2484); Ohio (B.M. 1336); South America (B.M. 2487).

8. *D. nigripes* Fries Syst. Myc., iii. 119 (1829). Plasmodium grey or colourless. Total height 1 to 1.5 mm. Sporangia gregarious, hemispherical, umbilicate beneath, stalked, erect, 0.5 to 0.7 mm. diam., white; sporangium-wall membranous, mottled with brown or colourless, beset with stellate crystals of lime. Stalk cylindrical, one to three times the height of the sporangium, longitudinally striate, varying in colour from dark olive-brown to orange-brown, translucent, not containing refuse matter. Columella subglobose, dark brown, filled with irregular angular crystals of lime. Capillitium of delicate colourless or purplish-brown branching threads. Spores pale violet-brown, nearly smooth, 8 to 11  $\mu$  diam.—Berk. in Sm. Engl. Fl., v. pt. 2, 313; Macbr. N. Am. Slime-Moulds, 90. *Physarum nigripes* Link in Mag. Ges. Nat. Fr. Berl., iii. Diss. 1, p. 27 (1809); Ditm. in Sturm Deutsch. Fl., Pilze, 85, t. 42 (1817). *P. microcarpon* Fr. Symb. Gast., 23 (1818). *Didymium microcephalum* Chev. Fung. & Byss. Ill., fig. 2 (1837). *D. porphyropus* Dur. & Mont. Fl. Alg., 409 (1846). *D. microcarpon* Rost. Mon., p. 157 (1875); Mass. Mon., 226. *D. tenue* Pat. in Bull. Soc. Myc., iv. 96 (1888).

Var. *eximium* Lister: stalk dark orange, columella orange or buff; sporangium-wall firm, usually buff.—*D. megalosporum* Berk. & Curt. in Grev., ii. 53 (1873). *D. eximium*

Peck in Rep. N. York Mus., xxxi. 41 (1879); Macbr. l.c., 92. *D. fulvellum* Mass. l.c., 237 (1892).

Var. *xanthopus* Lister: stalk orange, columella white.—*Cionium xanthopus* Ditm. l.c., 87, t. 43. *C. iridis* Ditm. l.c., 13, t. 7. *Diderma lobatum* Somm. Suppl. Fl. Lapp., 240 (1826)? *Didymium xanthopus* Fr. Sy t. Myc., iii. 120; Macbr. l.c., 91. *D. iridis* Fr. l.c., 120. *D. lobatum* var. *stipitatum* Fr. l.c., 123? *D. pertusum* Berk. l.c., 313; Mass. l.c., 241. *D. proximum* Berk. & Curt. in Grev., ii. 52 (1873); Rost. Mon., App. p. 23. *D. elegantissimum* Mass. l.c., 243.

Pl. 102.—*a.* sporangia (England); *b.* capillitium and spores with fragment of sporangium-wall; *c.* spore; *d.* sporangia of var. *eximium* (Mexico); *e.* sporangia of var. *xanthopus*; *f.* capillitium and spores of same; *g.* spore of same; (England).

The above varieties have been distinguished by specific names, depending on the colour of the stalk, columella, and capillitium. The capillitium may vary however from white to purplish-brown in the same group of sporangia, and the colour of the stalk and columella is also inconstant. The specimen B.M. 885, from Ravenel, South Carolina, is intermediate between the typical form and the var. *eximium*, having some sporangia with dark brown and others with deep orange stalks and columellae on the same leaf. *D. eximium* Peck and *D. fulvellum* Mass. have orange-red stalks, with the columellae orange or buff. The type of *D. proximum* Berk. & Curt. from South Carolina (K. 1493) has orange-red stalks and a pale buff columella. The type of *D. pertusum* Berk. from Appin, N.B. (K. 463) has orange stalks and a white columella; it corresponds with the description of *D. xanthopus* Fries in all essential characters. *D. elegantissimum* Mass. from Charlottenburg (K. 1) is the same variety. These forms blend into one another so completely that they are here united under *D. nigripes*. In this species the upper part of the stalk as well as the columella occasionally contains crystals of lime, as in *D. melanospermum*.

*Hab.* On dead leaves and twigs. Common.—Lynton, Devon (B.M. 1338); Lyme Regis (B.M. 1339); Epping Forest, Essex (B.M. 1337); Wilts (B.M. 2488); North Wales (B.M. 2489); France (Paris Herb.); Germany (B.M. 1558); Switzerland (B.M. 555); Portugal (B.M. 2490); Ceylon (B.M. 561); Singapore (B.M. 1935); Philippine Islands (B.M. 2038); Ohio (B.M. 1341); South Carolina (B.M. 884); Dominica (B.M. 1750); Brazil (B.M. 1776); Chili (Strassb. Herb.): var. *eximium*.—Wanstead, Essex (B.M. 2491); Muskoka, Canada (B.M. 2493); New Jersey (B.M. 566); South Carolina (B.M. 885); Colorado (B.M. 2492); Mexico (B.M. 2494): var. *xanthopus*.—Somerset (B.M. 59); Staffordshire (B.M. 1342); Edinburgh (K. 440); Appin, N.B. (K. 463); Germany (Strassb. Herb.); Italy (K. 334); Switzerland (Herb. Zürich); Portugal (B.M. 2495); Ceylon (B.M. 577); Penang (B.M. 1730); Australia (B.M. 562); Philippine Islands (B.M. 2042); Japan (B.M. 2001); Massachusetts (B.M. 1343); New York (B.M. 564); South Carolina (K. 1492); Antigua (B.M. 1665); Brazil (B.M. 2496); Bolivia (B.M. 2497).

9. *D. squamulosum* Fr. Symb. (Gasterom.), 19 (1818). Plasmodium colourless. Sporangia gregarious, subglobose or hemispherical, umbilicate beneath, 0.5 to 1 mm. diam.,

stalked, sessile, or forming effused plasmodiocarps, snow-white from abundant stellate crystals, which often form a wrinkled deciduous scaly outer crust, or grey when the crystals are more scanty; in the plasmodiocarp forms the crystals are often sparsely distributed; sporangium-wall membranous, sometimes mottled with red-brown towards the base, at length breaking up into small fragments. Stalk white or pale yellow, rarely orange, cylindrical, deeply furrowed, rough with deposits of lime in minute crystals, varying much in length, discoid at the base. Columella large or small, white or yellowish, hemispherical, absent in effused plasmodiocarps. Capillitium variable, of slender or coarse threads, either almost simple or branching at an acute angle, colourless, violet, or purplish-brown, usually with dark calyciform thickenings. Spores violet-brown, 8 to 11  $\mu$  diam., faintly or distinctly spinulose, the spinules often grouped in clusters.—Fr. Syst. Myc., iii. 118; Rost. Mon., p. 159; Mass. Mon., 223; Macbr. N. Am. Slime-Moulds, 87. *Diderma squamulosum* Alb. & Schw. Consp. Fung., 88 (1805). *Licea stipitata* DC. Fl. Fr., ed. 2, 101 (1815). *Didymium effusum* Link in Mag. Ges. Nat. Fr. Berl., 42 (1815); Rost. l.c., p. 163; Lister Mycetozoa, 99. *D. herbarum* Fr. l.c., 120. *D. leucopus* Fr. l.c., 121. *D. costatum* Fr. l.c., 118. *D. filamentosum* Wallr. Fl. Crypt. Germ., no. 2187 (1833)? *D. radiatum* Berk. & Curt. in Journ. Linn. Soc., x. 348 (1869); Mass. Mon., 229, in part. *D. Chondrioderma* de Bary & Rost. in Alex. Stroj. &c., p. 89 (1872). *D. neglectum* Berk. & Br. in Journ. Linn. Soc., xiv. 83 (1873). *D. Fuckelianum* Rost. Mon., p. 161 (1875). *D. praecox* de Bary in Rab. Fung. Eur., no. 367 (1861); Rost. l.c., p. 163. *D. macrospermum* Rost. l.c., p. 161. *D. discoideum* Rost. l.c., p. 162. *D. confluens* Rost. Mon., App. p. 22 (1876). *D. platypus* Hazsl. in Oester. Bot. Zeitschr., xxvii. 83 (1877)? *D. angulatum* Peck in Rep. N. York Mus., xxxi. 41 (1879). *D. Cookei* Raunk. in Bot. Tidssk., xvii. 86 (1888). *D. Bonianum* Pat. in Journ. de Bot., v. 316 (1891). *D. Alexandrowiczii* Mass. l.c., 232 (1892). *D. Tussilaginis* Mass., l.c., 244. *D. affine* Raunk. l.c., 88, t. v, figs. 3, 4. *Physarum confluens* Pers. Syn., 169 (1801)?; Fr. l.c., 146, in part? *P. alatum* Fr. l.c., 132? *P. Tussilaginis* Berk. & Br. in Ann. Mag. Nat. Hist., ser. 4, xvii. 139 (1876). *Chondrioderma anomalum* Rost. Mon., p. 169. *C. Alexandrowiczii*, Rost. l.c., p. 169. *Chondrioderma Cookei* Rost. Mon., App. p. 17 (1876).

Pl. 109.—*a.* sessile sporangia, one is broken and shows the white columella (England); *b.* stalked sporangia; *c.* plasmodiocarp form without columella; *d.* sporangium with wrinkled crust (Devon); *e.* spore of same, marked with clustered warts; *f. g. h.* capillitium and spores of various forms, with crystals from sporangium-wall; *i.* spore of the usual form.

The numerous varieties which occur in this common and widely distributed species have led to different forms receiving specific rank. Observations conducted for a length of time on large growths among one heap of leaves show that the colour of the capillitium varies from almost black to colourless in the same locality; a cluster on one leaf may present several shades, and even in a single sporangium one-half of the capillitium may be dark and the other half colourless; this difference of colour is seen in all forms, from the stalked sporangia to effused plasmodiocarps. The stalk and columella may vary from white to bright orange. The spinules on the spores are sometimes minute, sometimes rather strongly developed, and are either regularly distributed or grouped in a few large or small clusters. Spores showing small clusters of rather larger spinules are of frequent occurrence in all forms of *D. squamulosum*, and are found indeed occasionally in most species of *Didymium*. The characters given as distinguishing *D. effusum*, *D. macrospermum*, *D. discoideum*, *D. praecox*, and *D. Fuckelianum* are so inconstant that they cannot be applied to mark even varieties of *D. squamulosum*. In the specimen marked *D. effusum* Rost. in Strassb. Herb., the sporangia are stalked or sessile, with slender white capillitium; in the sporangium examined the threads in one portion are without any thickenings; in the remaining part there are numerous small fusiform expansions containing lime, an irregular development not infrequent in this species; the spores are minutely spinulose. The specimen of *D. macrospermum* in Strassb. Herb. has colourless capillitium springing from a large white columella; the spores are strongly spinulose, 10 to 11  $\mu$  diam.; the size of the columella in the present species is very variable, and the large development in the Strassburg specimen of *D. macrospermum* is by no means exceptional. *D. praecox* is described as having two walls; the type specimen at Strassburg is the frequent form of the present species, with the crust of crystals on the sporangium-wall wrinkled and scaly. *D. discoideum* and *D. Fuckelianum* are distinguished by the coloured stalk, columella, and capillitium, and by the spotted membrane of the sporangium-wall; these characters are met with in different degrees in *D. squamulosum*, associated with sporangia having white stalks and colourless walls and capillitium. The type of *D. radiatum* Berk. & Curt. from Cuba (K. 1516) is nearly destroyed; only the stalks remain, but these are characteristic of the present species, being white, deeply furrowed, granular with deposits of lime and arising from a discoid base. *Chondrioderma Alexandrowiczii* Rost., the type specimen of which from Poland is in the Strassburg Herb., is probably a form of *D. squamulosum*; the sporangia are sessile and have the capillitium and spores of that species; it differs from the typical form in the almost entire absence of lime. A specimen from Lyme Regis has the sporangium-wall similar to that of the Polish specimen; in both cases it is membranous with cloudy brown spots, and with calcareous deposits in the form of minute scattered spicules; the capillitium in both is violet-brown, beset with short spines, and colourless at the extremities; the columella in both is represented by a brown thickening of the base without lime deposits; the points of difference are that in the Polish specimen the sporangia are subglobose or of irregular shape on a broad base, and the sporangium-wall is crumpled and whitish; in the Lyme Regis specimen the sporangium is a depressed plasmodiocarp, and resembles a *Lamproderma* in the iridescent wall; but it is associated with other sporangia scantily furnished with lime, and also with

those of the usual form. *Chondrioderma Cookei* Rost., of which the type from Cheshire on leaves of *Tussilago* is represented both in Strassb. Herb. and Brit. Mus. (B.M. 137), is also the present species; it differs from the usual form with sessile sporangia in having scanty deposits of lime scattered in the form of minute spicules over the sporangium-wall; the capillitium is an irregular network of dull violet threads, with expansions containing nodules of lime such as are of frequent occurrence in imperfect developments both in this species and its allies; the spores are spinulose, 10 to 12  $\mu$  diam.

*Hab.* On dead leaves, straw, etc. Very common.—Lyme Regis, Dorset (B.M. 1347); Bathaston, Somerset (B.M. 37); Sydenham, Surrey (B.M. 1070); Yorks (K. 462); Ireland (B.M. 2498); France (K. 12); Germany (B.M. 530); Austria (B.M. 567); Italy (B.M. 433); Portugal (B.M. 2499); Ceylon (B.M. 456); Java (B.M. 2500); New Zealand (K. 1324); Japan (B.M. 2004); London, Canada (B.M. 1796); Washington State (B.M. 2502); Iowa (B.M. 2503); Kansas (B.M. 2501); Vermont (B.M. 1349); Philadelphia (B.M. 1350); South Carolina (K. 89); Antigua (B.M. 1666); Cuba (K. 542); Brazil (B.M. 2504); Chili (Paris Herb.); Paraguay (Paris Herb.).

10. *D. anellus* Morgan Myx. Miami Valley, 64, t. xii. fig. 41 (1894). Plasmodium colourless. Sporangia scattered, sessile, usually orbicular, umbilicate above, 0.3 to 0.5 mm. diam., often forming slender plasmodiocarps elongated into links and chains, grey, or glossy brown from absence of lime; sporangium-wall membranous, colourless or purplish-brown, sparingly beset with minute crystals of lime, at length dehiscing in a circumcissile manner. Columella none. Capillitium consisting of slender flexuose violet-brown threads, simple or somewhat branched and anastomosing. Spores purplish-grey or purplish-brown, minutely spinulose, 7 to 9  $\mu$  diam.—Petch in Ann. Perad., iv. 349. *D. effusum* var. *tenue* Lister in Journ. Bot., xxxv. 214 (1897).

Pl. 110.—*a.* sporangia (Essex); *b.* capillitium and spores with fragment of sporangium-wall; *c.* spore.

This species has been obtained from various parts of the world, and, though closely resembling slender plasmodiocarp forms of *D. squamulosum*, appears to retain its distinctive characters, namely the circumcissile mode of dehiscence and the centrally depressed sporangia.

*Hab.* On dead leaves.—Wanstead Park, Essex (B.M. 1716); Witley, Surrey (B.M. 2506); Yorks (B.M. 2507); Ceylon (B.M. 2505); Ohio (B.M. 2059).

11. *D. Wilczekii* Meylan in Bull. Soc. Vaud. Sci. Nat., xlv. 290 (1908). Plasmodium grey. Sporangia scattered, forming elongated curved or almost net-like plasmodiocarps, 1 to 2 mm. wide, 1 mm. to 3 cm. long, 0.3 to 0.5 mm. thick, white, or glossy brownish-purple when without lime; sporangium-wall dehiscing irregularly, membranous or somewhat cartilaginous, colourless, yellowish or pale purplish, with superficial deposits of minute stellate, rod-shaped, or nodular crystals of lime, sometimes without any lime. Columella



hardly developed, represented by the colourless or yellowish-brown base of the sporangium-wall, which is usually thickened beneath with a network of strands containing a few minute lime crystals. Capillitium very abundant, consisting of pale brownish-purple often slender threads combined to form an elastic network, readily separating from the sporangium-walls. Spores purple-brown, minutely and closely spinulose, 9 to 13  $\mu$  diam.

Pl. 194.—*a*, *b*. plasmodiocarps (Jura Mountains); *c*. capillitium with fragments of sporangium-walls; *d*. spore.

This alpine species resembles the stouter plasmodiocarp forms of *D. squamulosum*, from which it is distinguished by the absence of a prominent columella, the dense elastic network of capillitium and the darker spores. M. Ch. Meylan describes the repeated occurrence of *D. Wilczekii*, often in great abundance, on open ground in the Jura Mountains at an altitude of 1,100 to 1,300 m. It appears in spring-time only, directly after the winter snows have melted; the sporangia are very fugacious, and a shower of rain is sufficient to wash them away. Dr. R. E. Fries has gathered what appears to be a form of the present species in subalpine situations near Frostviken, Jämtland, Sweden; the long stout plasmodiocarps either have lime deposits in the form of minute rod-shaped crystals, or are entirely without lime; the capillitium threads are stout and dark; the whole growth so closely resembles the sporangia of *Lepidoderma Carestianum* often found associated with it on the same twigs and herbage, that in writing to Dr. Fries we gave it as our opinion that his specimens might be a "*Didymium* form" of the latter species (see R. E. Fries in Ark. Bot., vi. No. 7, p. 3, & Lister in Journ. Bot., xlv. 218). M. Meylan's observations, however, have established the constancy of this alpine *Didymium*, and the Swedish gatherings should be referred to *D. Wilczekii*.

*Hab.* On turf and twigs in alpine situations.—Ste. Croix, Jura (B.M. 2508); Arolla, Vallais, Switzerland (B.M. 2509); Frostviken, Sweden (B.M. 2510).

12. *D. intermedium* Schroet. in Hedwigia, xxxv. 209 (1896). Plasmodium? Sporangia gregarious or clustered, stalked, discoid, convex above, widely and deeply umbilicate beneath, often lobed or sinuous, 0.5 to 1 mm. diam., greyish white; sporangium-wall membranous, clothed with superficial deposits of lime crystals. Stalk 0.7 to 1 mm. long, pale yellow or buff, broad at the base and tapering upwards, filled like the columella with crystalline nodules of lime. Columella convex, discoid, pale yellow or white, formed by a shallow thickening of the base of the sporangium-wall, recurved at the margin owing to the deeply umbilicate character of the sporangium. Capillitium of simple or branched slender colourless threads. Spores dark purple-brown, 9 to 12  $\mu$  diam., marked with a close irregular reticulation of minute ridges making a border about 0.7  $\mu$  deep.—*D. excelsum* Jahn in Ber. Deutsch. Bot. Gesell., xx. 275, t. xiii, figs. 5 to 10 (1902).

Pl. 110.—*d*. sporangia, two have the walls and capillitium broken away exposing the columella; *e*. capillitium and spores; *f*. spore; (Brazil).

This species was obtained by Dr. A. Möller at Blumenau, Brazil. It is allied to *D. squamulosum*, from which it is distinguished by the shape of the sporangia and the markings of the spores; the latter closely resemble those of *Mucilago spongiosa* var. *dictyospora* in both colour and reticulation.

*Hab.* On herbaceous stems.—Blumenau, Brazil (B.M. 1770).

**13. *D. crustaceum*** Fries Syst. Myc., iii. 124 (1829). Plasmodium white. Sporangia globose, confluent, aggregated or scattered, shortly stalked or sessile, 0.7 to 2 mm. diam., smooth and white from the thick fragile deciduous crust of loosely compacted crystals of lime in which they are enclosed; when the crust has fallen away the sporangia appear reniform or hemispherical and grey; sporangium-wall membranous, colourless, clothed with large stellate crystals of lime. Stalks pale buff, 0.2 to 0.4 mm. high, membranous, eight or ten often clustered together on an expansion of the membranous hypothallus, at first concealed under the crust of lime enclosing the sporangia. Columella small, irregular, depressed, scarcely evident in the sessile forms, white or pale buff, more or less charged with nodules of lime. Capillitium consisting of colourless or pale violet branching threads 0.5 to 1  $\mu$  diam., often with minute fusiform thickenings. Spores purplish-grey, strongly spinulose, 10 to 13  $\mu$  diam.—Rost. Mon., App. p. 22; Macbr. N. Am. Slime-Moulds, 86. *D. confluens* Rost. Mon., p. 164 (1875); Mass. Mon., 235.

Pl. 111.—*a.* sporangia (Devon); *b.* cluster of sporangia from which the outer crust of lime has fallen away; they arise from a common hypothallus, in one the wall and capillitium are gone and the columella is exposed; *c.* capillitium and spores with crystals from the outer crust, also a portion of the columella with three nodules of lime; *d.* spores.

This species does not appear to be common; it has been found in Devon, Dorset and Hants, North Wales and Poland; Rostafinski refers to gatherings from France, Denmark, Germany, Russia, Finland and San Domingo; Prof. Macbride finds it in Iowa, U.S.A. It is closely allied on the one hand to *D. squamulosum* and on the other to *Mucilago spongiosa*. The nomenclature given by Rostafinski of earlier date than that of Fries is very uncertain, and may apply equally well or better to other species.

*Hab.* On dead leaves and grass.—Near Lyme Regis, Dorset (B.M. 1354); North Wales (B.M. 3195); Poland (B.M. 1353).

**14. *D. leoninum*** Berk. & Br. in Journ. Linn. Soc., xiv. 83 (1873). Plasmodium orange-red. Sporangia gregarious, stalked, subglobose, 0.6 to 0.7 mm. diam., either dark purplish-brown and glossy, broadly veined with white or buff deposits of lime, or pale all over from being completely clothed with lime crystals; sporangium-wall at length breaking up into fragments, cartilaginous, chestnut-brown with thinner yellow lines of dehiscence (when seen by transmitted light); crystals

of lime large, stellate. Stalks yellow, orange, or brown, 0.4 to 0.6 mm. high, often connected at the base by a vein-like hypothallus, of spongy consistency within, and usually charged, like the columella, with nodular crystals of lime. Columella subglobose, orange. Capillitium consisting of slender purple-brown threads, branched and anastomosing, colourless at the extremities. Spores violet-grey, 7 to 9  $\mu$ , minutely warted all over; about nine warts can be counted in a row across the hemisphere.—Lister in Journ. Bot. xlv., 187; Petch in Ann. Perad., iv. 350. *Lepidoderma tigrinum* Rost. Mon., App. p. 23 (1876), in part; Lister Mycetozoa, 106, in part; Penzig Myx. Buit., 51. *Lepidodermopsis leoninus* v. Höhnelt in Sitzungsber. k. Akad. Wiss. Wien, Math.-Nat. Kl., cxviii. 439, fig. 35 (1909).

Pl. 113.—*a.* sporangia (Ceylon); *b.* sporangia after the capillitium and spores have fallen away, showing the columellae; *c.* capillitium and spores, with fragment of columella and sporangium-wall with crystals of lime; *d.* spore.

This handsome species is closely allied to *Lepidoderma tigrinum*, which it resembles in the cartilaginous sporangium-wall, and in the structure of the orange stalk and columella; it differs in the sporangia being clothed with stellate crystals of lime, as in other *Didymia*, in the sporangium-wall at length breaking up into areolae, and in the paler smaller spores. Since the first gathering by Thwaites in Ceylon of the immature specimen that forms the type (K. 1554), this species has been found several times in that island by Mr. Petch, in perfect condition. It has been collected on various occasions in Java by Professors Penzig and Engler, and also by Prof. von Höhnelt; the latter makes it the type of a new genus, *Lepidodermopsis*.

*Hab.* On dead leaves.—Ceylon (B.M. 2511); Java (B.M. 2512).

The following species are rejected by Rostafinski for what appear to be sufficient reasons (see Rost. Mon., p. 229-301):—

*D. Linkii* Fr.

*D. muscicola* Link.

*D. nanum* Fr. & Weinm.

*D. parietinum* Schrad.

*D. plicatum* Corda.

*D. Weinmanni* Fr.

*D. Sowerbeii* Berk. in Sm. Engl. Flora, v. pt. 2, 313, must also be discarded as the description is too imperfect for instruction.

Genus 16.—**MUCILAGO** Adanson Fam. Pl., ii. 7 (1763). The sporangia are confluent to form an aethalium, otherwise the characters are those of the genus *Didymium*.—*Spumaria* Pers. in Gmel. Syst. Nat., ii. 1466 (1791).

1. *M. spongiosa* Morgan in Bot. Gaz., xxiv. 56 (1897). Plasmodium white or yellow. Aethalia composed of elongated compressed lobed and confluent grey sporangia, arising in

more or less loosely compacted clusters from branching processes of the membranous hypothallus, clothed with a thick but fragile and deciduous white universal covering of crystals of lime; 2 to 6 cm. long, 1 to 6 cm. wide, and about 1 cm. thick; sporangium-wall membranous, purplish or colourless. Columella membranous, hollow, compressed, following in its branches the form of the confluent sporangia, sometimes absent. Capillitium a network of widely branching anastomosing stout purplish-brown or colourless threads, often with dark calyciform thickenings, hyaline at the extremities where it is attached to the sporangium-wall or columella; the threads are accompanied occasionally by tubular processes of the sporangium-wall, which open externally, and either completely perforate the flattened lobes of the sporangia or are continued into the capillitium threads. Spores dull purple, strongly spinulose, 10 to 13  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 83. *Mucor spongiosus* Leysser Fl. Hal., 305 (1783). *Reticularia alba* Bull. Champ., 92, t. 326 (1791). *Spumaria Mucilago* Pers. l.c. *S. cornuta* Schum. Enum. Pl. Saell., ii. 195 (1803). *S. alba* DC. Fl. Fr., ii. 261 (1805); Fr. Syst. Myc., iii. 95; Rost. Mon., p. 191; Lister Mycetozoa, 104. *Didymium spumarioides* Fr. l.c., 121 (1829). *Diderma spumariaeforme* Wallr. Fl. Germ. Crypt., 374 (1833).

Var. 1.—**dictyospora** Fr. in Arkiv. Bot., i. 66 (1903): lime crystals small, nodular; capillitium irregular, pale; spores very dark, closely reticulated, 12 to 13  $\mu$  diam.

Var. 2.—**solida** Sturgis in Colorado. Coll. Publ., Sci. Ser., xii., 29 (1907): aethalia pulvinate compact, 4 to 5 cm. diam., lime crystals small, often nodular; capillitium scanty, colourless, irregular; spores spinulose, 9 to 11  $\mu$  diam.

Pl. 117.—*a.* aethalium (England); *b.* cluster of sporangia from an aethalium; in three places they are broken and show hollow columellae; *c.* capillitium and spores, with crystals from the outer covering of lime; *d.* spore; *e.* spore of var. *dictyospora*.

This species is closely allied to *Didymium crustaceum*, but is distinguished by its aethalioid habit. In some seasons the cream-yellow plasmodium and large greyish-white aethalia form conspicuous features about the blades and stalks of grass in pastures, especially in autumn. The var. *dictyospora* was first gathered by Dr. R. E. Fries in Bolivia; it has since been found in some abundance in company with the typical form about old straw heaps in Bedfordshire; the aethalia are more compact than in the type, and in the field are not always easily distinguishable from those of *Fuligo cinerea*. The var. *solida* is a still more massive form; it has been recorded hitherto from the State of Colorado only.

*Hab.* On grass, dead leaves, etc., common in Europe and the United States.—Highgate, Middlesex (B.M. 161); Bedfordshire (B.M. 2514); Oxfordshire (B.M. 1083); Somerset (B.M. 171); Cromarty (B.M. 1088); Ireland (K. 584); France (B.M. 997); Belgium (B.M. 594);

Germany (B.M. 599); Finland (B.M. 597); Poland (Strassb. Herb.); Hungary (B.M. 1822); British Columbia (B.M. 2516); Ohio (B.M. 1358); Iowa (B.M. 1359); Colorado (B.M. 2515); Bolivia (B.M. 2513).

The type of *Spumaria Micheneri* Berk., from Pennsylvania (in Grev., ii. 52, 1873), is not represented in the quoted collections, and the description is too brief to be of value; the species should therefore be discarded.

Genus 17. — **LEPIDODERMA** de Bary in Rost. Versuch, 13 (1873). Sporangia stalked, sessile, or forming plasmodiocarps; sporangium-wall cartilaginous, beset with superficial crystalline discs or scales; capillitium rigid and without lime (except in *L. Carestianum* var. *granuliferum*).

### KEY TO THE SPECIES OF *LEPIDODERMA*.

- |   |                          |
|---|--------------------------|
| Sporangia with orange stalks.   | 1. <i>L. tigrinum</i>    |
| Sporangia rarely with short drab stalks, usually sessile or forming plasmodiocarps. | 2. <i>L. Carestianum</i> |

1. *L. tigrinum* Rost. Versuch, 13 (1873). Plasmodium orange-yellow. Sporangia scattered, subglobose, flattened and umbilicate beneath, stalked, rarely sessile, 1 to 1.5 mm. diam., olive- or purplish-grey, glossy, more or less closely beset with rounded, angular, or star-shaped crystalline scales of lime; sporangium-wall cartilaginous, of two closely combined layers, orange-yellow. Stalk stout, cylindrical 0.2 to 0.7 mm. high, furrowed, orange-brown, of a spongy texture within, containing deposits of lime; rising from a hypothallus which is either vein-like or effused and of a loose reticulated structure. Columella hemispherical, orange, of the same texture as the stalk, containing deposits of lime in rounded nodules. Capillitium profuse, of straight or flexuose threads, sparingly branched, dark purple-brown or grey. Spores dark purplish grey, minutely and closely spinulose, 10 to 13  $\mu$  diam.—Rost. Mon., p. 187; Mass. Mon., 253; Macbr. N. Am. Slime-Moulds, 106. *Didymium tigrinum* Schrad. Nov. Gen. Pl., 22 (1797); Fr. Syst. Myc., iii. 117. *D. rufipes* Fr. l.c., 116. *D. versipelle* Fr. l.c., 117? *Physarum squamulosum* Pers. Syn., 174 (1801). *P. tigrinum* Pers. l.c. *Leangium squamulosum* Fr. Stirp. Femsj., 83 (1827). *Diderma citrinum* Berk. in Sm. Engl. Fl., v. pt. 2, 310 (1836) (*non* Schum.). *Lepidoderma fulvum* Mass l.c., 253 (1892).

Pl. 114.—*a.* sporangia (North Wales); *b.* capillitium and spores with fragment of sporangium-wall showing crystalline scales; *c.* spore.

This species occurs not unfrequently in company with *Diderma ochraceum* (q.v.) to which it appears to be closely allied. The specimens of *L. fulvum* Mass., from Scarborough (Herb. Mass.), and from Belle Croix, France (K. 1555; Paris Herb.), are immature gatherings of the present

species; the spores appear warted under a high magnifying power, though the warts are faint from their unripe condition; the French specimen is part of the large gathering by Roussel, and is given as an example of *L. tigrinum* by Rostafinski (Mon., p. 188).

*Hab.* On fir wood, moss, etc.—Leighton, Beds (B.M. 1360); North Wales (B.M. 2517); Inverary, N.B. (K. 568); France (K. 1555); Sweden (B.M. 2519); Denmark (K. 1557); Germany (B.M. 2518); Italy (Strassb. Herb.); Massachusetts (B.M. 1361); Washington State (B.M. 2520).

**2. *L. Carestianum*** Rost. Mon., p. 188 (1875). Plasmodium dirty white. Sporangia subglobose, often confluent, or forming short or elongate pulvinate plasmodiocarps, 1 to 15 mm. long, 0.5 to 1 mm. thick, brownish-grey, closely beset with white crystalline scales of lime; sporangium-wall cartilaginous, dark brown. Columella hemispherical, or hardly evident and represented by the thickened dark brown base of the sporangium-wall, enclosing rounded nodules of lime. Capillitium of colourless or purple-brown branching and anastomosing threads 1 to 2  $\mu$  thick. Spores dark purplish-grey, minutely spinulose, 10 to 15  $\mu$  diam.—Mass. Mon., 255; Schinz Myxom. Schweiz, 63. *Reticularia Carestiana* Rabenh. Fung. Eur., no. 436 (1862).

Var. 1.—***Chailletii*** Lister: sporangia globose or hemispherical, 0.5 to 1 mm. diam., sessile, shortly stalked or forming plasmodiocarps, grey or drab, with close-set crystalline scales of lime, usually seated on a well-developed brown scaly hypothallus; sporangium-wall cartilaginous, yellowish; stalk brown, 0.1 to 0.2 mm. high, containing like the columella abundant lime-nodules; columella pale or dark brown, rarely orange, clavate, hemispherical or scarcely evident; capillitium more slender than in the type; spores 10 to 13  $\mu$  diam.—Lister in Journ. Bot., xlv. 218 (1908). *Lepidoderma Chailletii* Rost. Mon., p. 189, fig. 179 (1875).

Var. 2.—***granuliferum*** Lister: sporangia hemispherical or forming elongate plasmodiocarps; columella hemispherical or hardly developed; capillitium of branching and anastomosing purplish-brown threads, with a few expansions, each enclosing one or two rounded nodules of lime, 20 to 30  $\mu$  diam., or forming a dense network of nearly colourless threads expanded at the nodes to form star-shaped vesicles, each usually enclosing a nodule of lime; spores purple-brown, 12 to 18  $\mu$  diam.—Schinz Myxom. Schweiz, 63 (1906). *Didymium granuliferum* Phill. in Grev., v. 114, t. 88, f. 1 a-f (1877). *Badhamia granulifera* Mass. Mon., 321 (1892). *Lepidoderma granuliferum* Fr. in Arkiv. Bot., vi. no. 7, p. 3 (1906).

Pl. 115.—a. plasmodiocarp (Switzerland); b. sporangia of var. *granuliferum* (Blue Cañon, California); c. capillitium and spores of the same; d. spores with fragment of sporangium-wall showing a crystalline scale, and capillitium partly normal, partly with expansions enclosing lime-nodules (Switzerland).

Pl. 116.—*a.* sporangia approaching var. *Chailletii* (Arolla, Switzerland); *b.* sporangia of var. *Chailletii* (Devonshire); *c.* sporangia with walls broken and showing columellae; *d.* capillitium and spores of same with fragment of sporangium-wall and crystalline scales; *e.* spore of same.

The most perfect development of this variable species appears to be represented by two British gatherings of the var. *Chailletii*, made respectively in Somerset and Devon, in winter time, by Miss Agnes Fry and Mrs. Montague. The sporangia are globose and provided usually with short stalks and well developed columellae. Rostafinski's type of *Lepidoderma Chailletii*, from Hauenstein, Bohemia, has hemispherical or elongated sporangia, sessile on broad bases, with columellae low and ridge-like or hardly developed; this variety appears to be a more alpine form, and is abundant on the Jura Mountains and on the Swiss Alps after the winter snows have melted. Every transition may be found between the var. *Chailletii* with sessile and often confluent sporangia, and the long plasmodiocarps of typical *L. Carestianum*. All stages also occur on the Alps between plasmodiocarps having normal capillitium free from lime, and those with capillitium branching to form the sponge-like network enclosing abundant lime-nodules characteristic of the var. *granuliferum*; the latter variety has now been obtained from California, Sweden and Switzerland. Prof. Farlow finds that the typical form is abundant on the mountains of New Hampshire in the spring-time.

*Hab.* On dead leaves, twigs, etc., chiefly in alpine regions.—Devon (B.M. 2521); Sweden (B.M. 2523); Jura (B.M. 2522); North Italy (B.M. 578); Chocorua, New Hampshire (B.M. 2524); California (B.M. 1362).

### Subcohort II.—*AMAUROCHAETINEAE*.

Sporangia single, or combined into an aethalium, without deposits of lime; capillitium and spores dark brown or violet-brown, rarely ferruginous or colourless.

### Order I.—*STEMONITACEAE*.

Sporangia stalked; sporangium-wall a delicate membrane, often evanescent; stalk extending within the sporangium as a columella from which the branching threads of the capillitium take their origin.

### KEY TO THE GENERA OF *STEMONITACEAE*.

Sporangium-wall evanescent; capillitium springing from all parts of the elongated columella, ultimate branchlets united to form a superficial net. (18) *STEMONITIS*.

Fig. 26.—*Stemonitis splendens* Rost.

*a.* Group of sporangia. Natural size.

*b.* Portion of capillitium and columella. Magnified 42 times.

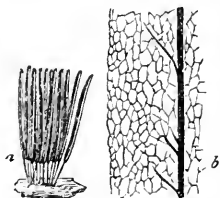


Fig. 26.

Sporangium-wall evanescent; capillitium as in *Stemonitis*, but not forming a superficial net, or only imperfectly towards the base of the sporangium. (19) *COMATRICHA*.

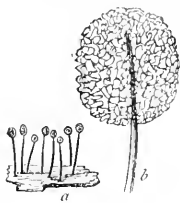


Fig. 27.

Fig. 27.—*Comatricha nigra* Schroeter.

a. Group of sporangia. Natural size.

b. Sporangium deprived of spores showing the capillitium. Magnified 16 times.

Sporangium-wall evanescent; columella reaching to the apex of the sporangium; capillitium springing from beneath the superficially expanded end of the columella.

(20) *ENERTHENEMA*.

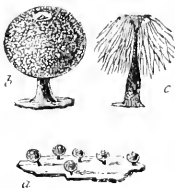


Fig. 28.

Fig. 28.—*Enerthenema papillata* Rost.

a. Group of sporangia. Twice the natural size.

b. Sporangium. Magnified 16 times.

c. Sporangium deprived of spores, showing the capillitium. Magnified 16 times.

Sporangium-wall somewhat persistent as an iridescent membrane; capillitium radiating from the columella.

(21) *LAMPRODERMA*.

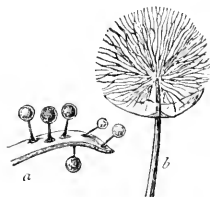


Fig. 29.

Fig. 29.—*Lamproderma scintillans* Morgan.

a. Group of sporangia. Magnified  $2\frac{1}{2}$  times.

b. Sporangium deprived of spores, showing capillitium. Magnified 25 times.

Sporangium-wall persistent in the form of minute discs at the apex of the rigid forking capillitium threads; columella short or hardly evident.

(22) *CLASTODERMA*.



Fig. 30.

Fig. 30.—*Clastoderma Debaryanum* Blytt.

a. Group of sporangia. Magnified 10 times.

b. Sporangia deprived of spores, showing capillitium. Magnified 64 times.



Capillitium scanty, colourless, branching from a short columella; sporangia very minute. (23) ECHINOSTELIUM.

Fig. 31.—*Echinostelium minutum* de Bary.

- a. Group of three sporangia. Magnified 20 times.  
 b. Sporangium showing capillitium, all the spores dispersed but two. Magnified 280 times.  
 c. Spore. Magnified 500 times.

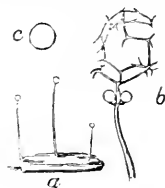


Fig. 31.

Genus 18.—**STEMONITIS** Gleditsch Meth. Fung., 140, tab. iv (1753). Sporangia cylindrical, stalked, fasciculate; the stalk extending within the sporangium to near the apex as a columella (except in confluent forms); capillitium formed of numerous threads radiating from all parts of the columella and combined into a loose network, the ultimate branches united into a superficial net.

#### KEY TO THE SPECIES OF *STEMONITIS*.

A. Spores grey, violet-grey, or rufous-violet :—

A. Spores reticulated, surface net of capillitium with angular meshes. 1. *S. fusca*

B. Spores minutely warted, almost smooth—

Meshes of surface net rounded, 20 to 100  $\mu$  or more wide (imperfect in var. *flaccida*); spores 7 to 9  $\mu$  diam.

2. *S. splendens*

Sporangia confluent, without definite surface net, spores 9 to 11  $\mu$ .

3. *S. confluens*

Meshes of smooth surface net angular, less than 20  $\mu$  wide; spores 7 to 8  $\mu$  diam.; plasmodium white; sporangia clustered.

4. *S. herbatica*

Meshes of uneven surface less than 20  $\mu$  wide; spores 7 to 8  $\mu$  diam.; sporangia in scattered groups.

5. *S. pallida*

B. Spores pale ferruginous :—

Spores 7 to 9  $\mu$  diam.; plasmodium yellow.

6. *S. flavogenita*

Spores 4 to 6  $\mu$  diam.; plasmodium white.

7. *S. ferruginea*

1. *S. fusca* Roth in Roem. & Ust. Mag. Bot., i. pt. 2, p. 26 (1787). Plasmodium white, in rotten wood, maturing at the place of emergence. Total height 5 to 20 mm. Sporangia cylindrical, obtuse, stalked, brownish-purple, at first closely

fasciculate. Stalk black, shining, 1 to 4 mm. long, rising from a well-developed brown membranous hypothallus. Columella reaching to near the apex of the sporangium. Capillitium of dark brown threads springing from all parts of the columella, combined into a loose network, the ultimate branches forming a delicate superficial net, with angular, unequal meshes varying from 6 to 16  $\mu$  wide. Spores grey or rufous-violet, reticulated with rows of minute spines or with raised bands, 8 to 10  $\mu$  diam.—Rost. Mon., p. 193; Mass. Mon., 72, in part. *S. fasciculata* Pers. Obs. Myc., 56 (1796). *S. maxima* Schwein. in Trans. Amer. Phil. Soc., ser. 2, iv. 260 (1832); Macbr. N. Am. Slime-Moulds, 116. *S. dictyospora* Rost. l.c., p. 195 (1875); Mass. l.c., 83. *S. nigrescens* Rex in Proc. Acad. Nat. Sci. Phil., 1891, 392; Macbr. l.c., 116. *S. castillensis* Macbr. in Bull. Nat. Hist. Iowa, ii. 381 (1893). *Clathrus nudus* L. Sp. Pl., 1179 (1753) ?

Var. 1.—**rufescens** Lister : spores faintly reticulated with rows of minute spines, 5 to 8  $\mu$  diam.

Var. 2.—**trechispora** Torrend : spores reticulated with raised bands.—Torrend Fl. Myx., p. 141.

Var. 3.—**flaccida** Lister : sporangia weak ; capillitium scarcely forming a surface net.

Var. 4.—**confluens** Lister : sporangia confluent, without superficial net or columellae.—*Amaurochaete speciosa* Zukal in Verh. Zool.-Bot. Gesell. Wien, xxxv. 335, t. 15, fig. 8.

Pl. 118.—*a. b.* sporangia (England) ; *c.* capillitium ; *d.* sporangia var. *rufescens*, sporangium uniting the characters of the typical form and of var. *rufescens* ; *i.* three *e.* capillitium of var. *confluens* ; *f.* spore ; *g.* spores, var. *rufescens* ; *h.* spores from one spores from one sporangium showing imperfect reticulation ; *k.* spores of var. *trechispora*, from Venezuela, South Carolina and Japan respectively.

This abundant species is the commonest form of *Stemonitis* in Europe and North America. The spores are never smooth, and when magnified 1,000 diam. present the following modifications in surface-markings ; these consist either of spines thickened and connected at their bases, forming a complete net with from 20 to 50 meshes on the surface of the hemisphere, and giving a continuous border to the spore ; or the spines are less connected, forming a broken net, and giving an irregular border to the spore ; or the spines are distinct, arranged on a more or less reticulate plan, giving a spinulose margin to the spore ; more rarely the spores are marked with a complete net of raised bands without spines. In the var. *rufescens* the sculpture is usually less pronounced, but the minute spines are arranged in the same manner as in the typical form, giving either a close or open reticulation to the surface of the spore (not evenly distributed as in the faintly warted spores of *S. splendens*). These two varieties represent well-marked centres, but there is no definite boundary between them denoting a true specific difference ; sporangia widely differing in length and with long or short stalks may have spores of either form ; the var. *confluens* occurs with both large and small spores. Rostafinski's specimens of *S. fusca* from Vera Cruz (B.M. 631) and from

Ruda Guzowska (Strassb. Herb.) have the spores measuring 7 to 8  $\mu$  diam.; they are not smooth, as he states, but show about 28 meshes of reticulation on the hemisphere. *S. dictyospora* Rost. appears to be an unnecessary name; it is represented in Kew Herb. by two specimens referred to in Rost. Mon., App. p. 27. One of these from Ceylon (K. 1622), bearing the signature of Rostafinski, is *S. fusca* var. *rufescens*; it has small spores, 5 to 6.5  $\mu$  diam., faintly reticulated with rows of spinules. The other specimen is from Venezuela, on a palm leaf (K. 1620, B.M. 648), and was marked by Berkeley *S. trechispora*. It consists of a number of small clusters of ill-developed sporangia with irregular columellae and imperfect surface net; the spores are 10 to 12  $\mu$  diam., marked with a strong complete reticulation in the form of raised bands giving an even border 1  $\mu$  broad. Other gatherings with spores showing a continuous reticulation of more or less raised bands have been made in Europe, Japan and North America; the spores, however, vary in size in the different specimens from 5 or 6  $\mu$  to 10 or 11  $\mu$ , the sporangia range from 2 to 6 mm. in height, and the capillitium also shows considerable variety. The banded reticulation of the spores is thus associated with such different forms that it does not appear to furnish a reliable character on which to found a distinct species; the various gatherings showing this feature are here placed under the var. *trechispora* of the present species. Small forms of *S. fusca* with spores measuring only 5–6  $\mu$  often show a close affinity to *Comatricha typhoides* var. *heterospora*, q.v., from which they differ chiefly in the more perfectly developed surface net of the capillitium. The type of *S. maxima* Schwein. has spores 7 to 8  $\mu$  diam. with reticulation precisely of the form above described of Rostafinski's *S. fusca* from Ruda Guzowska. The type of *S. nigrescens* Rex, from Philadelphia, has small sporangia with dark spores 8  $\mu$  diam. reticulated as in typical *S. fusca*. The description and figure of *Amaurochaete speciosa* Zukal leave little doubt that this is the var. *confluens* of the present species. The confluent form of the sporangia may in some cases be seen throughout the whole development from one plasmodium, the capillitium consisting of a profuse network of arching threads with broad expansions at the nodes; but sometimes only a part presents the confluent form, and is associated with more or less perfect sporangia with the normal superficial net.

*Hab.* On dead wood. Common.—Leytonstone, Essex (B.M. 1363); Lyme Regis, Dorset (B.M. 2525); Batheaston, Somerset (B.M. 208); Wales (K. 1601); Edinburgh (K. 796); France (Paris Herb.); Germany (B.M. 623); Austria (B.M. 626); Switzerland (B.M. 2527); Italy (B.M. 621); Poland (Strassb. Herb.); Russia (Paris Herb.); Portugal (B.M. 2526); Ceylon (K. 1622); Singapore (B.M. 1367); Java (K. 1591); Australia (B.M. 635); New Zealand (K. 666); New Caledonia (Paris Herb.); Philippine Islands (B.M. 2046); Tonga (B.M. 1368); Japan (B.M. 2528); British Columbia (B.M. 2529); Iowa (B.M. 1366); Philadelphia (B.M. 1910); Texas (B.M. 919); Nicaragua (B.M. 1002); Vera Cruz (B.M. 631); Antigua (B.M. 2530); Brazil (K. 686); Venezuela (B.M. 648).

2. *S. splendens* Rost. Mon., p. 195 (1875). Plasmodium creamy-white. Total height 6 to 20 mm. Sporangia cylindrical, obtuse, stalked, purplish-brown, closely fasciculate. Stalk black, shining, slender, 1 to 4 mm. long, rising

from a well-developed silvery or purplish hypothallus. Columella reaching to near the apex of the sporangium, rigid. Capillitium of purplish-brown threads, the principal branches springing at distant intervals from the columella, at first almost simple, suddenly branching to form a smooth superficial net with rounded variously shaped meshes 20 to 70  $\mu$  wide. Spores pale reddish-purple, nearly smooth, or minutely and closely warted, 7 to 9  $\mu$  diam.—Torrend Fl. Myx., 141. *Stemonitis Morgani* Peck in Bot. Gaz., v. 33 (1880); Mass. Mon., 86; Macbride N. Am. Slime-Moulds, 118. *S. maxima* Mass. (non Schwein.) l.c., 74. *S. Bauerlinii* Mass., see Rex in Proc. Acad. Nat. Sci. Phil. 1890, 36; Mass. l.c., 79 (1892). *S. acuminata* Mass. l.c., 78. *S. fenestrata* Macbr. l.c., 119.

Var. 1.—**Webberi** Lister : sporangia stiff, erect ; superficial net complete, with meshes 80 to 100  $\mu$  wide.—*S. Webberi* Rex in Proc. Acad. Nat. Sci. Phil., 1891, 390 ; Macbr. l.c., 120.

Var. 2.—**flaccida** Lister : plasmodium white or pale yellow ; sporangia weak, adhering to each other ; capillitium lax, scarcely forming a superficial net ; membranous flakes of sporangium-wall always present.—*Comatricha flaccida* Morg. Myx. Miami Valley 51 (1894) ; Macbr. l.c., 133. *Stemonitis Tubulina* Alb. & Schw. Consp. Fung., 102 (1805) ? *Dermodium fallax* Nees Syst., 109, f. 103 (1816). *Jundzilla Tubulina* Racib. in Hedw., xxvi. 111 (1887).

Pl. 121.—*a. b. c.* sporangia ; *d.* capillitium of specimen from Texas quoted by Rostafinski ; *e.* capillitium with membranous expansion, from Cuban specimen quoted by Rostafinski ; *f.* capillitium of *S. Morgani* Peck ; *g.* sporangia of var. *flaccida* ; *h.* capillitium of same, with a persistent flake of the sporangium-wall ; *i.* spore.

The typical form of this species does not appear to be common in Europe ; it is plentiful in India, America, Australia, and the Pacific Islands, from which regions there are numerous specimens in the Strassburg, British Museum and Kew collections, which were classed under *S. fusca* until Rostafinski detected the specific characters and gave the name of *S. splendens*. The capillitium in this species exhibits wide differences, but the spores are remarkably constant in colour, size, and in the minute, evenly distributed warts, which are sometimes scarcely apparent even when magnified 1,000 diam. The evanescent sporangium-wall appears to be at first continuous with the superficial net of the capillitium and is not merely attached by short spines projecting from the net as in *S. fusca*. This character is illustrated by a remarkable form described by Dr. Rex (in Proc. Acad. Nat. Sci. Phil., 1890, 36) under the name *S. Bauerlinii* Mass., *f. fenestrata*. He records the appearance of successive growths of the *Stemonitis* at considerable intervals of time on a limited area of a decaying log, apparently from one original source. Through the courtesy of Dr. Rex the gatherings are represented in the mountings in the British Museum. In mounting (*a*) the sporangium-wall is persistent, forming a sheath perforated by circular or oval openings 10 to 20  $\mu$  wide, or in other words the superficial net is expanded to form a perforated wall to the sporangium. Mounting (*b*)

is from a later gathering, with much of the character of (*a*), but approaching nearer to the normal form. Mounting (*c*) is from a crop appearing a month later than (*b*), in which there is a still more marked return to the usual habit, with the meshes of the net 30 to 60  $\mu$  wide. The width of the mesh varies much in Rostafinski's specimens from Cuba and Texas (referred to in Rost. Mon., App. p. 27). In that from Cuba (B.M. 630) the average width of the mesh is 70  $\mu$ ; in that from Texas (K. 1631) it is 20  $\mu$ . *S. Morgani* Peck, as illustrated by Ellis & Everhardt in N. Am. Fungi, 2088, and *S. Bauerlinii* Mass. from New Guinea (K. 726), are essentially the same form as the Cuba specimen, the mesh of the superficial net averaging about 60  $\mu$  in width. The var. *Webberi*, published by Dr. Rex as *Stemonitis Webberi*, has a wider surface mesh than the typical form; the type from Kansas is described as having the spores ferruginous-coloured in mass, and the surface capillitium pale; the mounted specimens do not show this difference of colour. This variety has been repeatedly gathered in Cornwall and the west of Ireland, as well as in Japan and North America. The var. *flaccida*, though closely resembling and merging into the var. *Webberi*, has even more lax and broken capillitium, and weaker columellae; the latter are sometimes imperfectly formed or absent, and the sporangia more or less confluent; the spores in mass are rich purple-brown. It appears to be common in the British Isles and throughout Europe, and has also been found in several of the United States of America. These two varieties are the only forms of *S. splendens* that have hitherto been found in the British Isles. In looking through a large series of specimens of this group there is a general character which runs through them all in the appearance of the spores and in the smooth purple-brown capillitium, which points to the conclusion that however widely the size of the mesh of the surface-net may vary, they are all forms of one species. The type of *S. acuminata* Mass. from the Cape is the typical form of *S. splendens* with spores measuring 7 to 8  $\mu$  (not 13 to 14  $\mu$  as given in Mass. Mon., 78.)

*Hab.* On dead wood.—Germany (B.M. 619); Italy (B.M. 999); Angola (B.M. 1637); Natal (K. 694); Uganda (B.M. 1162); Madagascar (Herb. Masee); Ceylon (Herb. Peradeniya); Australia (K. 716); New Zealand (K. 688); New Caledonia (B.M. 1093); Samoa (B.M. 1372); Japan (B.M. 2005); Iowa (B.M. 820); Ohio (B.M. 1373); Darien (B.M. 913); Cuba (B.M. 630); French Guiana (Paris Herb.); Brazil (B.M. 1089): var. *Webberi*—Falmouth (B.M. 2531); Killarney (B.M. 2532); Ceylon (B.M. 1740); Japan (B.M. 2533); Ohio (B.M. 1375); Jamaica (B.M. 2534): var. *flaccida*—Devon (B.M. 1377); London (B.M. 2535); Surrey (B.M. 2537); Cambridge (B.M. 2538); Germany (B.M. 2539); Sweden (B.M. 2540); Bohemia (B.M. 2541); New Zealand (B.M. 2542); Ohio (B.M. 1376).

**3. *S. confluens*** Cooke & Ellis in Grev., v. 51 (1876). Plasmodium white. Sporangia clustered, confluent; stalks short, indistinct; columellae branched and irregular; surface net when present with wide irregular meshes. Spores reddish-purple, 8 to 11  $\mu$  diam., spinulose.—Mass. Mon., 77; Macbr. N. Am. Slime-Moulds, 114. *S. splendens* var. *confluens* Lister Mycetoza, 112.

Closely allied to *S. splendens*, of which it may possibly be a confluent form; the spores, however, appear to be always larger and darker.

*Hab.* On dead wood, leaves, etc.—New Forest, Hants (B.M. 2543); Epping Forest, Essex (B.M. 2544); Beds (B.M. 2545); France (Paris Herb.); New Jersey (B.M. slide); North Carolina (B.M. 935).

4. *S. herbatica* Peck in Rep. N. York Mus., xxvi. 75 (1874). Plasmodium white, rarely pale yellow. Sporangia cylindrical, in densely fasciculated clusters, 5 to 9 mm. high, reddish-brown. Stalks 0.8 to 2 mm. high, arising from a membranous hypothallus. Capillitium of dark brown threads, springing from the columella and forming a very loose network, uniting at the surface into a net with rounded meshes, 10 to 20  $\mu$  diam. Spores pale reddish-grey, minutely spinulose, 6 to 8  $\mu$  diam.—Mass. Mon., 87. *S. axifera* Macbr. N. Am. Slime-Moulds, 120 (1899), in part.

**Var. confluens** Lister: sporangia united to form a convolute aethalioid mass, with somewhat persistent sporangium-walls, without distinct stalks or columellae; capillitium an irregular network.

Pl. 120.—*a.* sporangia (Peck's type from New York); *b.* capillitium; *c. d.* spores; *e.* capillitium of Java specimen; *f.* sporangia (Rangoon); *g.* capillitium of same.

The above description is made from Peck's type, kindly furnished by Dr. Rex. *S. herbatica* holds an intermediate position between *S. flavogenita* and *S. splendens*, having the denser capillitium and the frequent habit of fruiting on herbaceous stems of the former species, and the stouter surface-net and purplish spores of the latter. Different gatherings show a tendency towards one or other of its allies; although not a sharply defined species it makes a useful centre under which to place forms possessing a distinct general character which were difficult to locate before Peck gave them a specific rank. Rostafinski united the present species with *S. fusca*, from which it is distinguished by the nearly smooth spores and the wandering habit of the plasmodium. A gathering of *S. herbatica* from Freiburg is marked in the Strassburg Herbarium by de Bary "*S. fusca* var. *minor leioperma*," while a small form of *S. fusca* from the same locality is named by him *S. fusca* var. *minor trachispora*. The var. *confluens* is remarkable in having persistent sporangium-walls; it has now been obtained from Epping Forest, Essex, from Ceylon, and from Connecticut, U.S.A. It was figured in the first edition of the present work as an exceptional form of *S. fusca* var. *confluens* (p. 111, Pl. lxxvii. A).

*Hab.* On dead leaves and wood.—Epping Forest (B.M. 2546); Witley, Surrey (B.M. 1713); Cambridge (B.M. 1714); Worcester (B.M. 2548); Aberdeen (B.M. 2547); North Germany (B.M. 2549); Switzerland (K. 1606); Italy (B.M. 1947); Portugal (B.M. 2550); Angola (B.M. 1636); Ceylon (B.M. 2551); Pondicherry (B.M. 84A); Rangoon (K. 1612); Java (B.M. 1091); Borneo (B.M. slide); Australia (K. 711); New Zealand (B.M. 2552); Japan (B.M. 2554); Philippine Islands (B.M. 2054); British Columbia (B.M. 2553); New York (B.M. 1378); Carolina (K. 1581): var. *confluens*—Epping Forest (B.M. 2555); Ceylon (B.M. 2556); Connecticut (B.M. 2557).

5. *S. pallida* Wingate in Macbr. N. Am. Slime-Moulds, 123 (1899). Plasmodium? Total height 5 to 6  $\mu$ . Sporangia scattered or clustered in small groups, cylindrical on short stalks, violet-brown; resembling *S. herbatica*, but differing in the scattered habit, the uneven pale surface net of the capillitium, and the firmer walled spores that assume a "coffee-bean" shape when dry.—Wingate in Ellis & Everh. N. Am. 64  
Fungi, no. 3498 (1897). *S. tenerrima* Morg. Myx. Miami Valley, 53 (1894). *S. carolinensis* Macbr. l.c., 122.

Pl. 120.—*h.* sporangia (Philadelphia); *i.* capillitium; *k. l.* spores, two are contracted and show the "coffee-bean" shape.

*Hab.* On dead wood.—Pennsylvania (B.M. 1748); Georgia (B.M. 2558); Alabama (B.M. 2559); South Carolina (B.M. 2560); Japan (B.M. 2564).

6. *S. flavogenita* Jahn in Abh. Bot. Ver. Brandenb., xlv. 165 (1904). Plasmodium translucent citron-yellow. Total height 5 to 7 mm. Sporangia cylindrical, obtuse, in closely fasciculate clusters, shortly stalked or nearly sessile, cinnamon-brown. Stalk black, 0.5 to 1.5 mm. high. Columella often ceasing below the summit of the sporangium. Capillitium of ferruginous or brown threads, springing from the columella, and forming a loose network with numerous broad membranous expansions; meshes of the delicate spinose superficial net angular, rather uneven, varying from 6 to 16 diam. Spores pale ferruginous, faintly warted, 7 to 9  $\mu$  diam.—Lister in Journ. Bot., xlii. 135 (1904); Torrend Fl. Myx., 144. *S. ferruginea* Fr. Syst. Myc., iii. 158 (1829), in part; Rost. Mon., p. 196, in part; Mass. Mon., 85, in part; Lister Mycetozoa, 114.

Pl. 119.—*a.* sporangia (England); *b.* capillitium; *c.* capillitium and columella, the latter expanded to form a membranous cap at the apex of the sporangium; *d.* spore.

This species is abundant in the British Isles, and appears to be not uncommon in Europe, but has not been found hitherto elsewhere. It is allied on the one hand to *S. herbatica*, and on the other to *S. ferruginea* under which species it was included by the earlier authors; from the former it is distinguished by the delicate spinose surface net of the capillitium and ferruginous spores, and from the latter by the shortly stalked sporangia and larger spores measuring 7 to 9  $\mu$ ; from both it differs in the yellow colour of the plasmodium. In the first edition of the present work this species is described under the name of *S. ferruginea* Ehrenb., but Dr. Jahn's researches have shown the type of the latter, preserved in the Berlin Museum, to be the following small-spored species, which was described as *S. Smithii* Macbr. in Mycetozoa, p. 115. Neither Fries nor Rostafinski distinguished the present species from *S. ferruginea*, the colour of whose plasmodium they describe as yellow.

*Hab.* On dead wood and leaves; the plasmodium often creeps from the place of emergence and matures on the surrounding herbage.—Lyme Regis, Dorset (B.M. 1380); Leigh-Wood, Somerset (B.M. 206);

Hartham, Wilts (B.M. 210); Wilmslow, Cheshire (B.M. 1381); North Wales (B.M. 2562); Aberdeen (B.M. 2561); France (Paris Herb.); Germany (K. 778); Hungary (K. 1616); Bohemia (B.M. 2563).

**7. *S. ferruginea*** Ehrenb. Sylv. Myc. Berol., 25 (1818). Plasmodium white. Total height 7 to 20 mm. Sporangia cylindrical, densely fasciculate, stalked, cinnamon-brown. Stalks black, 3 to 7 mm. long, arising from a membranous hypothallus. Columella ceasing below the apex of the sporangium. Capillitium much as in *S. flavogenita*, but the superficial net is connected with the columella by fewer branches and has rounded, more regular meshes, 5 to 10  $\mu$  diam.; the threads of the surface net are usually rather stout. Spores pale ferruginous, nearly smooth, 4 to 6  $\mu$  diam.—Rost. Mon., p. 196, in part; Mass. Mon., 85, in part; Jahn in Abh. Bot. Ver. Brandenb., xlv. 164 (1904). *Trichia axifera* Bull. Champ., 118, t. 477, fig. 1 (1791)? *S. fasciculata* Schum. Enum. Pl. Saell., ii. 216 (1803)? *S. violacea* Schum. l.c.? *S. Smithii* Macbr. N. Am. Slime-Moulds, 121; Lister Mycetozoa, 115. *S. microspora* Lister in litt. ex Morgan Myx. Miami Valley, 54 (1894).

**Var. *Smithii*** Lister: sporangia 3 to 6 mm. high, with surface net of very slender threads, and intermediate capillitium well developed.—*S. Smithii* Macbr. in Bull. Nat. Hist., ii. 381 (1893). *S. subclavata* Zoll. in Flora, xxx. 301 (1847)?

Pl. 119.—*e.* sporangia of various sizes (England); *f.* capillitium; *g.* spore.

This abundant and widely distributed species is subject to much variation in the size of the sporangia and the stoutness of the capillitium. The type of var. *Smithii* from Nicaragua has minute sporangia with capillitium showing abundant intermediate network and a very slender surface net; the same form has now been found in many places, and is connected with typical *S. ferruginea* by numerous gatherings showing intermediate characters: it bears considerable resemblance to *Comatricha typhoides* var. *microspora* from which it is distinguished by the more even and perfect surface net and the smoother spores.

**Hab.** On dead wood.—Epping Forest, Essex (B.M. 1384); Dudley, Stafford (B.M. 1382); Luton, Beds (B.M. 1383); Reigate, Surrey (B.M. 2567); Northumberland (B.M. 2569); Aberdeen (B.M. 2568); Germany (B.M. 2570); Switzerland (B.M. 2565); Bohemia (K. 729); Austria (B.M. 1830); Sweden (B.M. 2571); Ceylon (B.M. 646); New Zealand (K. 771); Australia (K. 758); Philippine Islands (B.M. 2049); Japan (B.M. 2566); Iowa (B.M. 819); Ohio (B.M. 1386); Mass., U.S.A. (B.M. 641); South Carolina (B.M. 644); Antigua (B.M. 1672); Darien (B.M. 643); Chili (Paris Herb.); Brazil (B.M. 1092); var. *Smithii*—Yorks (B.M. 2572); Jura Mountains (B.M. 2573); Ceylon (B.M. 2574); Java (B.M. 2575); Montreal (B.M. 2576); New York (B.M. 2577); Ohio (B.M. 1387); Nicaragua (B.M. 1004).



Genus 19.—**COMATRICHA** Preuss in Linnaea, xxiv. 140 (1851). Sporangia cylindrical, ovoid or globose, gregarious or scattered; sporangium-wall evanescent (subpersistent in *C. typhoides*), stalked, the black solid stalk extending within the sporangium as a columella for half its length or more, branching above, and continued into the capillitium, which consists of numerous threads combined into a more or less uniform network, not uniting to form an even superficial net.

The genus *Comatricha* is a somewhat artificial one, for it includes species which agree with *Lamproderma* in all characters but the persistent sporangium-wall, and with *Stemonitis* in all but the presence of the superficial net of the capillitium, while in *C. typhoides* a surface net is often developed on the lower half of the sporangium; at the same time it is a useful genus, typically marked by the uniform network of the capillitium and by the isolated not fasciculate growth of the sporangia.

## KEY TO THE SPECIES OF *COMATRICHA*.

### A. Spores rather dark brownish-violet or grey:—

#### a. Spores nearly smooth—

Capillitium dense, crisped or flexuose, usually arising from the whole length of the columella; spores brown in mass, 7 to 10  $\mu$  diam.; on wood. 1. *C. nigra*

Resembling *C. nigra*, but spores black in mass, 10 to 11  $\mu$  diam. 2. *C. Suksdorfii*

Capillitium with primary branches stout and nearly straight, arising from the whole length of the columella; on wood. 3. *C. laxa*

Capillitium dense, arising by a few branches only from the apex of the columella. 4. *C. elegans*

#### b. Spores spinulose or reticulated—

a. Sporangia globose; columella ending in strong branches continued into the flexuose network of the capillitium; spores warted; on leaves. 5. *C. lurida*

#### b. Sporangia long, slender, cylindrical—

Spores closely reticulated. 9. *C. longa*

Spores spinulose. 10. *C. irregularis*

### B. Spores pale; lilac or reddish lilac:—

a. Spores marked with a few widely scattered warts, otherwise smooth, or (in var. *heterospora*) delicately reticulated, 4 to 6  $\mu$  diam.; on wood (var. *microspora* on leaves). 8. *C. typhoides*

- B. Spores minutely spinulose or nearly smooth, 6 to 10  $\mu$  diam.—

Sporangium-wall completely evanescent; on leaves (on wood in var. *gracilis*). 6. *C. puchella*

Sporangium-wall persistent at the base as a membranous cup attached to the capillitium on leaves.

7. *C. rubens*

1. **C. nigra** Schroeter in Cohn Krypt. Fl. Schles., iii. pt. 1. 118 (1885). Plasmodium watery-white. Total height 1 to 6 mm. Sporangia globose, ellipsoid or cylindrical, stalked, scattered or gregarious, about 0.6 mm. diam., purplish-brown; sporangium-wall evanescent. Stalk subulate, slender, black, shining; in the globose form usually 2 to 6 times the length of the sporangium, equalling the length of the sporangium or shorter in the cylindrical form, rising from a more or less distinct hypothallus. Columella reaching to half the height, or nearly to the apex of the sporangium, branching above and continued into the capillitium. Capillitium a more or less dense tangle of purplish-brown threads, springing from all parts of the columella, anastomosing and branching in semi-circular curves; of nearly equal thickness throughout, the ultimate branches looped and showing few free ends but often marked with short spine-like branchlets. Spores brownish-violet, nearly smooth, or minutely and closely spinulose, 7 to 11  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 128; Sturgis in Colorado Coll. Publ., Sci. Ser., xii. 33. *Stemonitis nigra* Pers. in Gmel. Syst. Nat., 1467 (1791). *S. atrofusca* Pers. in Roemer N. Mag. Bot., 91 (1794). *S. reticulata* Trentep. in Roth Catal. Bot., i. 223 (1797)? *S. ovata* Pers. Syn., 189 (1801). *S. globosa* Schum. Enum. Pl. Saell., ii. 217 (1803)? *S. obtusata* Fr. Syst. Myc., iii. 160 (1829). *S. Friesiana* de Bary in Rabenh. Fung. Eur., no. 568 (1863); Mass. Mon., 82. *S. subcaespitosa* Mass. l.c., 80 (1892). *Trichia alba* Sow. Engl. Fung., t. 259 (1803) (*nomen*). *Comatricha obtusata* Preuss in Linnaea, xxiv. 141 (1851); Lister Mycetozoa, 117. *C. Friesiana* Rost. Mon., p. 199 (1875). *C. subcaespitosa* Peck in Rep. N. York Mus., xliii. 25 (1890). *C. Persoonii* Cel. fil. Myx. Böhm., 50, t. 2, f. 4, 5; Macbr. l.c., 132, in part.

Var. 1.—**alta** Lister: sporangia oblong or cylindrical; capillitium a tangle of long flexuose threads attached chiefly by a few branches to the base of the columella.—*C. alta* Preuss l.c., 141, and in Sturm Deutschl. Fl., Pilze, vi. 141, t. 71 (1862).

Var. 2.—*aequalis* Sturgis l.c., 34: sporangia slender, cylindrical, 2 to 4 mm. long, on slender stalks 2 to 2.5 mm. high; capillitium a dense network of violet-brown threads.—*C. aequalis* Peck in Rep. N. York Mus., xxxi. 42 (1879); Macbr. N. Am. Slime-Moulds, 131. *Stemonitis aequalis* Mass. Mon., 80.

Pl. 123.—*a. b.* round sporangia (England); *c.* capillitium of same; *d.* cylindrical sporangia with capillitium of same; *d.* cylindrical sporangia with capillitium attached chiefly near the base of the columella (= form named *C. alta* by Preuss.); *e. f.* capillitium and spore of same; *g.* base of a small sporangium (fig. *b*) showing capillitium with surface net; *h.* cylindrical sporangia (England); *i.* sporangia of var. *aequalis* New Hampshire; *m. n.* capillitium and spore of same.

A very abundant species in Europe, and not uncommon in some States of North America. A single development often exhibits much variation in the shape and size of the sporangia and in the network of the capillitium. With the usual form, minute sporangia may occur showing a close even surface net in the lower part of the capillitium, or they may approach *C. laxa* in having few and rigid capillitium branches (cf. *C. Persoonii* Cel. fil., l.c.). The var. *alta* is of frequent occurrence in the British Isles; the tangle of capillitium at length falls away from the upper part of the columella, leaving the naked spike-like apex exposed. The var. *aequalis* is a tall slender form connected with typical *C. nigra* by many intermediate gatherings. *C. subcaespitosa* Peck has slender ellipsoid sporangia, 2 mm. high with the flexuose capillitium threads forming a more or less distinct surface net in the lower part; the spores measure 10 to 12  $\mu$ ; although an unusually short-stalked delicate form it presents no characters by which it can be separated from *C. nigra*.

*Hab.* On dead wood.—Batheaston, Somerset (B.M. 220); Lyme Regis, Dorset (B.M. 1388); Boynton, Yorks (B.M. 1095); Hexham, Northumberland (B.M. 2578); Aberdeen (B.M. 2580); Ireland (B.M. 2582); France (Paris Herb.); Germany (B.M. 605); Norway (B.M. 2579); Sweden (B.M. 1728); Finland (B.M. 612); Poland (Strassb. Herb.); Switzerland (B.M. 2581); Bohemia (Herb. Dr. Celakovsky); Portugal (Herb. Dr. Torrend); Ceylon (Peradeniya Herb.); Japan (B.M. 2583); Washington State (B.M. 2584); Colorado (B.M. 2585); Ohio (Paris Herb.); Massachusetts (B.M. 1389); Maine (K. 657); Antigua (B.M. slide); Brazil (B.M. 1774); var. *alta*—Stafford (B.M. 2586); near Salisbury, Wilts (B.M. 2587); near Dorchester (B.M. 2588); var. *aequalis*—New York (B.M. slide); New Hampshire (B.M. 2589); New Mexico (Herb. Dr. Sturgis).

2. *C. Suksdorfii* Macbr. N. Am. Slime-Moulds, 132 (1899). Plasmodium? Sporangia scattered, globose or cylindrical, 0.5 to 0.9 mm. diam., purple-black. Stalk cylindrical, 0.3 to 0.7 mm. high. Capillitium a network of flexuose black threads springing from all parts of the columella. Spores 9 to 13  $\mu$ , purplish-grey, faintly spinulose.—*Stemonitis Suksdorfii* Ellis & Everh. in Bull. Washburn Coll., i. 5 (1882); Mass. Mon., 76. *Comatricha obtusata* Lister Mycetozoa, 118, in part. *C. nigra* var. *Suksdorfii* Sturgis in Colorado Coll. Publ., Sci. Ser., xii. 33 (1907).

Pl. 123.—*i.* capillitium (Colorado); *k.* spore.

This robust species is closely allied to *C. nigra*, with which it is connected by intermediate forms. Prof. Macbride finds that the distinguishing characters are well retained in repeated gatherings from the Western States of America. *C. Suksdorfii* has also been obtained from the Swiss Alps.

*Hab.* On dead wood.—Furstenalp, Switzerland (B.M. slide); Colorado (B.M. 2590).

3. *C. laxa* Rost. Mon., p. 201 (1875). Plasmodium watery-white. Total height, 1.5 to 3.5 mm. Sporangia subglobose or shortly cylindrical, obtuse, scattered or gregarious. Stalk black, shining, often stout, 0.2 to 0.6 mm. long. Columella reaching nearly to the apex of the sporangium, narrowed upwards. Capillitium usually lax, the primary threads springing somewhat distantly from all parts of the columella, at first straight or slightly curved, branching towards the surface to form a loose network of slender threads, either looped or with numerous straight free ends. Spores as in *C. nigra*.—Macbr. N. Am. Slime-Moulds, 127. *Stemonitis laxa* Mass. Mon., 79. *Badhamia penetrans* Cooke & Ellis in Grev., v. 49 (1876)? *Lamproderma Ellisiana* Cooke in Ann. Lyc. Nat. Hist. N. York, xi. 397 (1877)? *Comatricha macrosperma* Racib. in Rozpr. Mat. Przyr. Akad. Krak., xii. 76 (1884). *C. Ellisiana* Ellis & Everh. N. Am. Fung., ser. 2, no. 2696 (1891). *C. Sommerfeltii* Blytt in Bidr. K. Norg., Sop. iii. 8 (1892). *C. Ellisii* Morg. Myx. Miami Valley, 49 (1894).

Pl. 124.—*a. b. c.* sporangia of various shapes (England); *d.* three sporangia showing capillitium; *e.* capillitium; *f. g.* spores.

Intermediate forms connect this species with *C. nigra*, of which it is hardly more than a marked variety. The type in the Strassburg collection is well rendered by the photographic figure in Rostafinski's Monograph; it is a globose form with coarse and lax capillitium. A similar form is found at Lyme Regis, together with growths having more elongated sporangia; among these there occur forms which are identical with *C. Ellisiana* Ellis & Everh. (B.M. 1800). *C. Sommerfeltii* Blytt has the lax capillitium of Rostafinski's type of *C. laxa*, but has larger spores, 11 to 14  $\mu$  diam.; the size of the spores, which in other respects resemble those of *C. laxa*, can scarcely support a separate specific rank being given to this gathering. I am indebted to Prof. Blytt for kindly submitting the type of *C. Sommerfeltii* for examination.

*Lamproderma Ellisiana* Cooke, is described as having spherical sporangia on subulate stalks, slender forking blackish-purple capillitium-threads radiating from the apex of the short columella, and pale lilac spores measuring 15 to 16  $\mu$ , grouped in clusters of five to six. Nothing now remains of the type from New Jersey (K. 614) but a few naked stalks; and whether the specimen was in part a *Lamproderma* as Massee regards it (Mon., 98), or a form of *Comatricha laxa* with spherical sporangia—the same form in fact as *Comatricha Ellisiana*, of which *L. Ellisiana* is quoted as a synonym by Ellis & Everhardt—cannot now be determined.

*Hab.* On dead wood, twigs, etc.—Leytonstone, Essex (B.M. 1390); Surrey (B.M. 2592); Lyme Regis, Dorset (B.M. 1391); Hants (B.M. 2593); Cornwall (B.M. 2591); Germany (Strassb. Herb.); Norway (B.M. slide); Portugal (B.M. 2594); Japan (B.M. 2595); New Jersey (B.M. 1800); Philadelphia (B.M. 2596).

4. *C. elegans* Lister Brit. Mus. Guide to Brit. Mycet., 31 (1909). Plasmodium white. Sporangia scattered or gregarious, globose, 0.2 to 0.5 mm. diam., purplish-brown. Stalks black, slender, subulate, 0.6 to 1 mm. high. Columella short, soon dividing into the few straight primary branches of the capillitium; these again branch repeatedly and form towards the surface of the sporangium a loose tangle of slender flexuose anastomosing threads; spores pale brownish-violet, very faintly spinulose, 8 to 10  $\mu$  diam.—*Rostafinskia elegans* Racib. in Rozpr. Mat. Przyr. Akad. Krak., xii. 77 (1884); Torrend Fl. Myx., 132. *Raciborskia elegans* Berl. in Sacc. Syll., vii. 400 (1888); Mass. Mon., 108; Lister Mycetozoa, 133.

Pl. 124.—*h.* sporangia (Ceylon); *i. k.* sporangia after dispersion of spores; *l.* capillitium threads; *m. n.* spores.

Although closely allied to *C. nigra* and connected with it by intermediate gatherings, this form has now been obtained from many parts of the world retaining the characteristic branching of the capillitium. *C. elegans* shows considerable resemblance to *Lamproderma arcyrionema*, but differs in the completely evanescent sporangium-wall and in the larger spores.

*Hab.* On dead wood.—Near Salisbury, Wilts (B.M. 2597); North Wales (B.M. 2598); Moffat, Scotland (B.M. 2599); Sweden (B.M. 2601); Poland (Raciborski's type); Portugal (B.M. 2602); Ceylon (B.M. 2603); Japan (B.M. 2605); South Carolina (B.M. 922); Colorado (B.M. 2604).

5. *C. lurida* Lister Mycetozoa, 119 (1894). Plasmodium watery-white. Total height 1.25 mm. Sporangia globose or subovoid, erect, 0.5 mm. diam., stalked, scattered, purplish-brown; sporangium-wall evanescent. Stalk setaceous, black, shining, 0.75 mm. long, rising from a circular brown hypothallus. Columella cylindrical, reaching to half the height of the sporangium, dividing into stout branches at the apex, and continued into the capillitium. Capillitium dark purplish-brown throughout, spreading from the upper part of the columella in flexuose anastomosing threads, with slender brown free ends. Spores spherical or subovoid, purplish-grey, coarsely warted, 8 to 10  $\mu$  diam.—Torrend Fl. Myx., 135.

Pl. 127.—*a.* sporangia (England); *b.* columella and capillitium, with a fragment of sporangium-wall to which spores are adhering; *c.* spore.

This species has the habit of *Lamproderma scintillans*, from which it is distinguished by the evanescent sporangium-wall, the more branching columella, the uniform colour of the flexuose capillitium, and also by the larger and more strongly warted spores. It resembles some forms of *C. nigra*, but differs essentially in the spores and habitat.

*Hab.* On dead leaves, especially those of holly and ivy.—Lyme Regis, Dorset (B.M. 1399); Reigate, Surrey (B.M. 2606); Witley, Surrey (B.M. 2607).

6. *C. pulchella* Rost. Mon., App. p. 27 (1876). Plasmodium watery-white. Total height 0.7 to 2 mm. Sporangia ovoid or cylindrical, stalked, scattered, lilac- or rufous-brown; sporangium-wall evanescent. Stalk black, 0.2 to 0.5 mm. high, rising from a circular, membranous hypothallus. Columella reaching nearly to the apex of the sporangium. Capillitium a network of flexuose anastomosing brown threads springing from all parts of the columella, looped at the surface, with few free ends. Spores pale lilac-brown or flesh-coloured, minutely warted, 6 to 8  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 129. *Stemonitis pulchella* Church. Bab. in Proc. Linn. Soc., i. 32 (1839) (*nomen*); Berk. in Ann. Mag. Nat. Hist., ser. 1, vi. 431, t. 12, fig. 11; Mass. Mon., 86. *Comatricha Persoonii* Rost. Mon., p. 201 (1875); Lister Mycetozoa, 122.

Var. 1.—*tenerrima* Lister: sporangia shortly cylindrical; stalks 0.5 to 1.5 mm. high; spores and slender capillitium threads flesh-coloured; on dead leaves and herbaceous stems.—*Stemonitis tenerrima* Curt. in Sill. Am. Journ., vi. 352 (1848); Berk. & Curt. in Grev., ii. 69.

Var. 2.—*fusca* Lister: sporangia as in the type, but with more rigid purplish-brown capillitium, and pale greyish-brown spores; on dead leaves and twigs.—Lister in Journ. Bot., xxxv. 215 (1897).

Var. 3.—*gracilis* Lister: sporangia narrowly cylindrical; stalks 0.2 to 0.5 mm. high; capillitium threads usually uniting to form a close uneven surface net; spores pale violet-grey, very faintly warted, 5.6 to 7  $\mu$ ; on dead wood—*C. gracilis* Wingate in Ellis & Everh. N. Am. Fung. ser. 2, no. 2094 (1888). *C. Persoonii* Macbr. N. Am. Slime-Moulds, 132, in part.

PL 126.—*a.* sporangia (England); *b.* capillitium and spores; *c.* spore; *d.* capillitium and spores of var. *fusca*; *e.* spore; *f.* sporangia of var. *tenerrima* (England); *g.* *h.* capillitium and spores of same; *i.* sporangia of var. *gracilis* (Japan); *k.* *l.* capillitium and spores of same.

This species is allied to *C. nigra* and *C. laxa*, but differs in the paler capillitium, and in the paler and more distinctly warted spores. The typical form is not uncommon in the British Isles and in Europe, but appears to be rare elsewhere; the vars. *tenerrima* and *gracilis* are widely distributed.

*Hab.* On dead leaves: var. *gracilis* on dead wood.—Lyme Regis, Dorset (B.M. 1396); Bristol (B.M. 230); Batheaston, Somerset (B.M. 221); Flitwick, Beds (B.M. 1398); Wanstead, Essex (B.M. 1397); North Wales (B.M. 2608); Germany (B.M. 2609); Switzerland (B.M. 2610); var. *fusca*—Batheaston (B.M. 224); Wanstead (B.M. 2611);

var. *tenerrima*—Cornwall ? (B.M. 217); Devon (B.M. 2612); France (B.M. 2613); Japan (B.M. 2614); Antigua (B.M. 1675); Philadelphia (B.M. slide); South Carolina (B.M. 904B); Brazil (B.M. 2615); var. *gracilis*—Vienna (B.M. 1831); Ceylon (B.M. 2616); Cameroons, West Africa (B.M. 2618); Japan (B.M. 2617); Philadelphia (B.M. 1884).

7. *C. rubens* Lister Mycetozaa, 123 (1894). Plasmodium watery-white. Total height 1 to 2 mm. Sporangia scattered, obovoid, ellipsoid, or subglobose, stalked, erect or inclined, 0.5 to 0.8 mm. long, 0.3 to 0.5 broad, pinkish-brown, shining below; sporangium-wall evanescent above, membranous and persistent in the lower quarter, pinkish-brown. Stalk setaceous, black, shining, 0.6 to 1.3 mm. long, rising from a circular brown hypothallus. Columella reaching to about two-thirds the height of the sporangium, branching at the apex. Capillitium of violet-brown threads, springing from all parts of the columella, broad at the base, more or less flexuose, anastomosing and branching at wide angles, often with flat expansions, gradually narrowing to the slender straight free ends; the persistent base of the sporangium-wall is connected with the lower part of the columella by capillitium threads with broad attachments. Spores pale lilac-brown, minutely spinulose, 7 to 8  $\mu$  diam.—Torrend Fl. Myx., 138.

Pl. 127.—*d.* sporangia (England); *e.* columella and capillitium, with the persistent base of the sporangium-wall; *f.* spore.

Closely allied to *C. pulchella*, but differing in shape, in the branching of the capillitium, and in the persistent base of the sporangium-wall, a character showing an approach to the genus *Lamproderma*.

*Hab.* On dead leaves.—Lyme Regis, Dorset (B.M. 1400); Witley, Surrey (B.M. 2622); Epping Forest, Essex (B.M. 2623); Flitwick, Beds (B.M. 2621); Bulmer, Yorks (B.M. 2620); Philadelphia (B.M. slide).

8. *C. typhoides* Rost. Versuch, 7 (1873). Plasmodium watery-white. Total height 2 to 3 mm. Sporangia gregarious, stalked, cylindrical, obtuse, at first silvery-grey from the presence of the soon evanescent wall, then lilac-brown, 1.5 to 2.3 mm. long, 0.5 mm. broad. Stalk black, clothed with the silvery membranous continuation of the sporangium-wall, 0.5 to 1.3 mm. long, 0.06 mm. thick, rising from a well-developed hypothallus. Columella reaching to nearly the summit of the sporangium, branching at the apex. Capillitium a close network of flexuose, pale brown threads, springing from all parts of the columella, the ultimate branches more slender, free, or forming an uneven net in the lower half. Spores pale lilac-brown, marked with 3 to 5 prominent warts or clusters of minute warts on the hemisphere, otherwise almost smooth or very minutely warted, 6 to 7  $\mu$  diam.—*Trichia typhoides* Bull. Champ., 119, t. 477, f. 2 (1791). *Stemonitis typhina* Wiggers

Prim. Fl. Hols., 110 (1780) ?\*; Pers. Obs. Myc., i. 57; Mass. Mon., 74. *Stemonitis typhoides* DC. Fl. Fr., ii. 257 (1805). *S. pumila* Corda Icones, v. 59 (1842). *S. affinis* Mass. l.e., 76. *S. atra* Mass. l.e., 78. *S. Carlylei* Mass. l.e., 84. *Comatricha typhina* Rost. Mon., p. 197 (1875). *C. affinis* Rost. l.e., p. 202. *C. Stemonitis* Macbr. N. Am. Slime-Moulds, 130 (1899).

Var. 1.—**heterospora** Rex in Proc. Acad. Nat. Sci. Phil., 1893, 367: sporangia more rufous in colour than in the typical form; sporangium-wall evanescent, stalk without a silvery sheath; capillitium forming an uneven surface net in the lower part; spores 5 to 6  $\mu$  diam., faintly reticulate between the warts which high magnification resolves into patches of close-meshed reticulation; on dead wood.—*Stemonitis pumila* Fr. Syst. Myc., iii. 159 ?; *S. virginiensis* Rex l.e., 1891, 391; Macbr. l.e., 117. *Comatricha dictyospora* Cél. fil. Myx. Böhm., 49 (1893).

Var. 2.—**microspora** Lister: sporangia with surface net very close and flexuose, spores nearly smooth, 3.5 to 4.5  $\mu$  diam; on dead leaves.

Var. 3.—**similis** Lister: sporangia slender, cylindrical; sporangium-walls evanescent; capillitium with an uneven surface net below; spores 6 to 7  $\mu$  diam., faintly warted with a few larger and many smaller warts; on dead wood.

Pl. 125.—*a.* sporangia (England); *b.* capillitium; *c.* spores; *d.* sporangia of var. *heterospora* (England); *e. f.* capillitium and spores of same; *g.* sporangia of var. *microspora* (England); *h. i.* capillitium and spores of same; *k.* sporangia of var. *similis* (Philadelphia); *m.* spore of same; *n.* sporangia of a form intermediate between var. *heterospora* and *Stemonitis fusca* (Colorado); *o. p.* capillitium and spores of same; *q.* spores of *Stemonitis virginensis* Rex.

This abundant and widely distributed species shows great variety in the denseness of its capillitium and the amount to which the surface net is developed. The scattered warts, or in var. *heterospora* the minute patches of close-meshed reticulation on the spores, first pointed out by Dr. Rex, are however always present. The type of *C. affinis*, Rost. from Freiburg, in the Strassburg collection, is not well developed as shown by the abundance of immature spores; but the capillitium is that of the present species, and the spores have the characteristic scattered warts. *Stemonitis atra* Mass., from New Zealand (K. 727), has spores 6 to 8  $\mu$  diam., and appears to be the usual form of *C. typhoides*. The var. *heterospora* is a well marked form. The reticulation on the spores is usually faint and irregular, and the capillitium often shows something of a surface net; intermediate forms with stronger spore-reticulation and with more or less definite surface net to the capillitium occur, connecting this variety with *Stemonitis fusca*. Such a form is seen in the specimen named *Stemonitis virginensis* Rex from the Alleghany Mountains, Virginia (B.M. 1914); it has small loosely clustered sporangia showing the dense capillitium of *C. typhoides*, but the spores are 6  $\mu$  diam. and marked with distinct

\* The early names quoted by Rostafinski as synonyms for this species, such as *Mucor Stemonitis* Scop., *Clathrus pertusus* Batsch, *Stemonitis typhina* Wiggers are accompanied by vague and imperfect descriptions. Bulliard's excellent figures of *Trichia typhoides* leave no doubt as to the species he represents.



irregular lax reticulation. Another intermediate form is B.M. 2625, from Switzerland, a gathering resembling *S. fusca* in capillitium, but the spores having a faint reticulation exactly like that of typical *C. typhoides* var. *heterospora*. The specimen named *C. dictyospora*, gathered by Dr. Celakovsky near Tabor, Bohemia (B.M. 2626), has small scattered sporangia with spores of the var. *heterospora* character, but with dark lax capillitium resembling that of *C. laxa*. In the present state of our knowledge we may regard these gatherings as forms of one variable species. The var. *similis* has hitherto been found only in the United States: the sporangia somewhat resemble those of *C. pulchella* var. *gracilis*, but differ in being much longer and in having spores marked with warts of unequal size.

*Hab.* On dead wood: var. *microspora* on dead leaves.—Leytonstone, Essex (B.M. 1392); Lyme Regis, Dorset (B.M. 2627); Luton, Beds (B.M. 2628); North Wales (B.M. 2629); Germany (B.M. 629); Switzerland (B.M. 2630); Poland (Strassb. Herb.); Portugal (B.M. 2631); Italy (B.M. 628); India (K. 1580); Java (B.M. 2633); New Zealand (K. 727); Japan (B.M. 2632); Iowa (B.M. 1394); Philadelphia (B.M. 1393); Antigua (B.M. 1674); Brazil (B.M. 2634); var. *heterospora*—Witley, Surrey (B.M. 2635); Swarraton, Hants (B.M. 2638); Northumberland (B.M. 2639); Scotland (B.M. 2636); Switzerland (B.M. 2637); Portugal (B.M. 2624); Bohemia (B.M. 2626); Massachusetts (B.M. 2640); Virginia (B.M. 1914); var. *microspora*—Lyme Regis (B.M. 1395); Berlin (B.M. 638); Ohio (B.M. 2641); var. *similis*—Iowa (B.M. 1007); South Carolina (B.M. 632).

9. *C. longa* Peck in Rep. N. York Mus., xliii. 24 (1890). Plasmodium? Sporangia clustered, stalked, cylindrical, elongated and slender, flexuose or drooping, 2 to 5 cm. long, black; sporangium-wall evanescent. Stalks very slender, 1 to 3 mm. long, black, rising from a well-developed membranous hypothallus. Columella continued to near the apex of the sporangium, very slender and wavy with zigzag flexures in the upper part, tapering in breadth from 20  $\mu$  at the base to 2  $\mu$  near the summit. Capillitium a lax network of dark brown threads, the terminal branches rigid, free, forking at an acute angle. Spores dark grey, spinulose, the spines connected at their bases by faint bands forming a close reticulation, 8 to 9  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 125; Petch in Ann. Perad., iv. 353. *Stemonitis longa* Mass. Mon., 83 (1892). *Comatricha equinoctialis* Torrend Fl. Myx., 138 (1909).

Pl. 122.—a, b, sporangia (Philadelphia); c, capillitium from upper part of sporangium; d, capillitium from lower part of sporangium; e, spores.

From the absence of any superficial net in the capillitium this species is placed in *Comatricha*, though in its fasciculate habit it resembles a *Stemonitis*. The capillitium varies in different gatherings; in some the threads are comparatively short, rigid throughout, and anastomosing but little; in others they form a profuse network with many membranous expansions and very slender free ends, but the character of the dark reticulated spores remains constant in all forms.

*Hab.* On dead wood.—South West Africa (B.M. 1635); Ceylon (Peradeniya Herb.); Java (B.M. 2643); Japan (B.M. 2644); Philadelphia (B.M. 900); South Carolina (B.M. 915); Nicaragua (K. 718); Cuba (K. 1603); Antigua (B.M. 1673); Brazil (B.M. 2645).

10. *C. irregularis* Rex in Proc. Acad. Nat. Sci. Phil., 1891, 393. Plasmodium? Sporangia crowded, stalked, cylindrical, 2 to 5 mm. high, blackish-brown. Stalk black, slender, 1 to 3 mm. high. Columella straight or flexuose, reaching nearly to the apex of the sporangium. Capillitium a close or lax network of arcuate purple-brown threads, becoming more slender towards the surface of the sporangium, and there forming an irregular net, or ending in numerous colourless free branchlets. Spores brownish-purple, often paler on one side, closely spinulose, 8 to 10  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 126. *Stemonitis crypta* Schwein. in Trans. Amer. Phil. Soc., iv. 260 (1832)? *Comatricha crypta* Macbr. in Bull. Nat. Hist. Iowa, ii. 139 (1893). *C. longa* var. *irregularis* Lister Mycetozoa, 120 (1894).

Pl. 122.—*f.* sporangia (Philadelphia); *g.* capillitium; *h.* spore of usual type; *i.* spore showing a faint reticulation.

This species is closely allied to *C. longa* with which it is connected by intermediate forms with more simple and rigid capillitium, and with spores either spinose or faintly reticulated. It has been suggested that *Stemonitis crypta* Schwein. was the present species, but the type specimen is utterly lost (*teste* Rex), and the description is too vague to be instructive.

*Hab.* On dead wood.—Maine, U.S.A. (B.M. 1608); Iowa (B.M. 1006); Colorado (B.M. 2646).

Genus 20.—**ENERTHENEMA** Bowman in Trans. Linn. Soc., xvi. 152 (1830). Sporangia stalked; columella reaching to the summit of the sporangium; capillitium springing from beneath the superficially extended apex of the columella.

1. *E. papillatum* Rost. Mon., App. p. 28 (1876). Plasmodium watery-white. Total height 1 to 1.5 mm. Sporangia gregarious, globose, stalked, erect, 0.5 to 0.75 mm. diam., black or purple-brown, crowned with the small iridescent salver-shaped rarely papillate apex of the columella; sporangium-wall evanescent. Stalk cylindrical or conical, black. Columella slender, cylindrical from a conical base, traversing the sporangium and expanding on the surface into a membranous disc 0.1 to 0.2 mm. broad. Capillitium threads spreading from the expanded apex of the columella, long, slender, black, sparingly branched, straight or flexuose. Spores greyish-brown, spinulose, 8 to 10  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 137. *Stemonitis papillata* Pers. in Roemer N. Mag. Bot., 90, t. 1, f. 4 (1794). *S. mammosa* Fr. Syst. Myc., iii. 161 (1829). *Arcyria atra* Schum. Enum. Pl. Saell., ii. 215 (1803). *Enerthenema elegans*

Bowm. l.c., t. 16 ; Berk. & Br. in Ann. Mag. Nat. Hist., ser. 2, v. 366 ; Rost. Mon., p. 209 ; Mass. Mon., 105 ; Lister Mycetozoa, 124. *E. Berkeleyana* Rost. Mon., App. p. 29 (1876) ; Mass. l.c., 106. *Ancyrophorus crassipes* Raunkiaer in Bot. Tidssk., xvii. 93 (1888) ; Mass. l.c., 107.

PL. 128.—*a.* sporangia (England) ; *b.* sporangia after dispersion of spores, showing the capillitium arising from the apical disc of the columella ; *c.* sporangium with capillitium arising from the whole length of the columella, found in company with sporangia having normal capillitium ; *d.* *e.* spores.

Occasionally the capillitium threads are much branched and spring from all parts of the columella, which may then terminate below the apex of the sporangium ; this is frequently the case if the sporangia have been slightly injured by being brought indoors in a young and sensitive state ; all conditions between this and the normal form occur in the same group of sporangia. The account and figure of *Ancyrophorus crassipes* Raunkiaer, well represent this variety. In what remains of the type of *E. Berkeleyanum* Rost., from South Carolina (K. 1643), no spores of an *Enerthenema* can be detected ; the specimen is beset with clusters of brown spores or dividing cells of a parasitic fungus. Berkeley and Broome describe this specimen as having the "spores produced in little heads surrounded by a common vesicle at the free apices of the flocci," and of this being "almost the only case in which the spores of a *Myxogaster* have been observed *in situ* ; *Ptychogaster* is the single exception." The sporangia are of the typical form of *E. papillatum*, and it is probable that the mould was mistaken by Berkeley and Broome for the true spores.

*Hab.* On dead wood.—Wanstead, Essex (B.M. 1401) ; Devon (B.M. 1402) ; Portbury, Somerset (B.M. 236) ; North Wales (B.M. 2647) ; Edinburgh (K. 1642) ; Ireland (B.M. 2648) ; France (Paris Herb.) ; Germany (Strassb. Herb.) ; Denmark (Herb. Raunkiaer) ; Switzerland (B.M. 2649) ; Portugal (B.M. 2650) ; Japan (B.M. 2651) ; South Carolina (K. 1643) ; Colorado (B.M. 2652).

Genus 21. — **LAMPRODERMA** Rostafinski Versuch, 7 (1873). Sporangia usually stalked, globose or ellipsoid (sometimes forming plasmodiocarps in *L. Lycopodii*) ; sporangium-wall membranous, somewhat persistent, shining with iridescent colours ; stalk black ; columella cylindrical or clavate, reaching to half or more than half the height of the sporangium ; capillitium consisting of branched anastomosing threads, radiating chiefly from the upper part of the columella.

## KEY TO THE SPECIES OF *LAMPRODERMA*.

### A. Spores more or less spinulose :—

A. Spores echinulate, 15 to 20  $\mu$  diam. 1. *L. echinulatum*

### B. Spores spinulose, or nearly smooth—

a. The dark flexuose capillitium arising by a few (6 to 9) branches from the apex only of the columella ; spores smooth. 2. *L. arcyrionema*

- b. Capillitium spreading in very numerous branches from the abruptly ending columella—

Capillitium threads dark, pale at the base.

3. *L. scintillans*

Capillitium purple, with hyaline tips; stalk usually 2 to 3 mm.

4. *L. columbinum*

Capillitium pale or brownish-purple; stalk 1 mm. or less.

5. *L. violaceum*

B. Spores reticulated.\*

6. *L. Lycopodii*

1. *L. echinulatum* Rost. Mon., App. p. 25 (1876). Plasmodium? Total height 2 to 4 mm. Sporangia gregarious, globose, stalked, erect, 0.5 to 1 mm. diam., shining with steel-blue or green reflections; sporangium-wall membranous, persistent, purplish or fuliginous. Stalk subulate or cylindrical, 1 to 2.7 mm. long, black, rising from a well-developed hypothallus. Columella cylindrical, obtuse, about half the height of the sporangium. Capillitium black, pale purplish-brown, or nearly colourless, spreading chiefly from the upper part of the columella, threads stout, sparingly forked and anastomosing, colourless and slender at the tips. Spores dark grey or brownish-purple, echinulate with black spines, 15 to 20  $\mu$  diam. — Lister in Journ. Bot., xxix. 261 (1891); Mass. Mon., 97. *Stemonitis echinulata* Berk. in Hooker Fl. Tasm., pt. 2, 268 (1860). *Lamproderma Listeri* Mass. l.c. (1892).

Pl. 134.—a. sporangia (New Zealand); b. columella of same; c. sporangia (Tasmania); d. columella and capillitium of same; e. capillitium threads; f. g. spores; h. sporangia (Moffat, Scotland); i. columella and capillitium; k. capillitium-threads.

In the type specimen from Tasmania many of the stalks are misshapen and tumid, and the primary branches of the capillitium are soon lost in a flaccid network of grey threads with broad expansions at the angles; somewhat similar appearances are met with both in the stalks and capillitium of *L. violaceum* when matured under unfavourable conditions, and this specimen is probably not well developed; the primary threads in some parts are continuous and branched towards the surface in the manner usual in *Lamproderma*. A specimen from New Zealand gathered by Colenso (B.M. slide) is mouldy and difficult to examine, but the capillitium forms less of a network, and more nearly approaches the British gatherings, which are perfect developments.

*Hab.* On dead wood.—Lyme Regis, Dorset (B.M. slide); Derbyshire (B.M. 2653); Moffat (B.M. slide); Ireland (B.M. 2654); Tasmania (K. 1621); New Zealand (B.M. slide).

2. *L. arcyrionema* Rost. Mon., p. 208 (1875). Plasmodium watery-white. Total height 1 to 2 mm. Sporangia gregarious,

\* See also *L. violaceum* var. *dictyosporum*.

globose, stalked, erect, 0.5 mm. diam., steel-grey, blue or bronze, shining iridescent; sporangium-wall membranous, pale purple, falling away in large fragments, persistent as a collar round the base of the sporangium. Stalk subulate-setaceous, about 1 mm. high, black, shining. Columella slender, smooth, cylindrical, reaching to one-third or one-half the height of the sporangium, suddenly dividing at the apex into the few primary branches of the capillitium. Capillitium of purple-brown or black threads arising from the apex of the columella, branching repeatedly and anastomosing to form a close crisped network, with very short free ends. Spores pale lilac-grey, very faintly warted, 6 to 7  $\mu$  diam.—Mass. Mon., 96; Macbr. N. Am. Slime-Moulds, 143. *Stemonitis physaroides* var. *subaeneus* Berk. in Herb. *Lamproderma subaeneum* Mass. l.c., 95. *Comatricha Shimekiana* Macbride in Bull. Nat. Hist. Iowa, ii. 380, t. x, fig. 3 (1893).

Pl. 129.—*a.* sporangia (Philadelphia); *b.* capillitium; *c.* sporangia (England); *d.* columella and capillitium of same; *e.* spore.

This widely distributed species appears to be especially abundant in the United States, where it is described by Dr. Rex as sometimes occurring in vast profusion, "covering one entire side of a fallen log about 3 feet in diameter for a length of about 10 feet with the steel-coloured sporangia." The specimens marked *Stemonitis physaroides* var. *subaeneus*, from Ohio in Berkeley's collection (K. 1560, 1562) correspond in every respect, in size, capillitium, and in the spores which measure 6 to 7  $\mu$ , with Rostafinski's type of *Lamproderma arcyronema* in Strassb. Herb. *Comatricha Shimekiana* Macbr. from Nicaragua (B.M. 1008), is a typical form of the present species. The sporangia of *L. arcyronema* are on the whole remarkably constant in character. A variety has been found near Kamawata, Japan, by Mr. K. Minakata (B.M. 2659), with unusually lax and slender capillitium, and with spores rather darker than in the typical form measuring 8 to 9  $\mu$  diam.

*Hab.* On dead wood.—Epping Forest, Essex (B.M. slide); Luton, Beds (B.M. 2655); Scarborough (B.M. 2656); France (Paris Herb.); Poland (B.M. slide); Portugal (B.M. 2658); Ceylon (B.M. 2657); Japan (B.M. 2006); Borneo (B.M. slide); Philadelphia (B.M. 1814); Ohio (B.M. 1406); Antigua (B.M. 1676); Nicaragua (B.M. 1008); Brazil (B.M. 2660).

3. *L. scintillans* Morgan Myx. Miami Valley, 47 (1894). Plasmodium watery-white. Total height 1 to 1.5 mm. Sporangia scattered or gregarious, globose, stalked, erect, 0.3 to 0.5 mm. diam., steel-blue, red or bronze, brilliantly iridescent; sporangium-wall delicately membranous, colourless, falling away in large fragments. Stalk setaceous, black, shining, rising from a purple-brown circular hypothallus. Columella cylindrical, truncate, scarcely reaching to half the height of the sporangium. Capillitium of rigid threads, radiating from the apex of the columella, dichotomously branching and anastomosing, black or purple-brown, pale at the base, rigid

and coloured to the free extremities; the threads connecting the apex of the columella with the somewhat persistent base of the sporangium-wall usually slender and colourless. Spores violet-grey, minutely warted, 6.5 to 8  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 142. *Stemonitis scintillans* Berk. & Br. in Journ. Linn. Soc., xv. 84 (1876). *Lamproderma arcyrioides* var. *iridea* Cooke Myx. Brit., 50 (1877). *L. irideum* Mass. Mon., 95 (1892); Lister Mycetozaa, 128. *Enerthenema muscorum* Lév. in Ann. Sci. Nat., ser. 4, xx. 289 (1863).

Pl. 130.—*a, b.* sporangia (England); *c.* capillitium and columella; *d.* branching thread of capillitium showing the colourless base; *e, f.* spores.

This species resembles some forms of *L. violaceum*, but is distinguished by the bases of the capillitium threads being pale where they spring from the truncate apex of the columella; apart from the character of the capillitium, which is liable to some variation, it can always be distinguished by the spores, which, instead of being minutely and closely spinulose as in the pale-spored form of *L. violaceum*, are marked with scattered warts that can easily be counted when magnified 1,000 diam., and number about thirty on the hemisphere. It is a most abundant species in England; in heaps of dead leaves it appears in countless numbers, and in a dark fir plantation near Lyme Regis the stones and herbage by the side of a rivulet appeared hoary over an area of many square yards with the young rising sporangia, and a little search showed the mature forms in equal abundance. The type from Ceylon (K. 1634) agrees in all characters with the English gatherings, and is well described by Berkeley. There are several specimens of this species in the Kew Collection, named *L. arcyrioides* var. *iridea* Cke. (K. 615—619); these are referred to in Mr. Massee's Monograph as having smooth spores measuring 11 to 16  $\mu$ , which is misleading. Specimens received from the United States, representing several gatherings, agree in all respects with the type. The type of *Enerthenema muscorum* Lév. from New Granada (B.M. 1032), appears to be a form of the present species; it is on moss, and consists of scattered sporangia on setaceous stalks, with rigid capillitium threads dark to the base; the spores measure 7.5 to 9  $\mu$ , and are marked with fewer and larger warts than in the type. Considering the unusual character of the gathering it seems better to retain Berkeley's specific name for the present species, which is associated with the typical form, rather than revive that given by Lévillé, although the latter is of earlier date.

*Hab.* On dead leaves, straw, etc. Common in the British Isles.—Lyme Regis, Dorset (B.M. 1407); Batheaston, Somerset (B.M. 194); Highgate, London (B.M. 1111); Epping Forest, Essex (B.M. 2661); Hitchin, Herts (B.M. 2662); France (B.M. 617); Sweden (Herb. Dr. R. E. Fries); Poland (Strassb. Herb.); Portugal (B.M. 2663); Ceylon (K. 1634); Java (B.M. 2665); Japan (B.M. 2664); New Jersey (B.M. 1911); Philadelphia (B.M. 1410); Ohio (B.M. 1409); Iowa (B.M. 1099); South Carolina (B.M. 846); Antigua (B.M. 1677).

4. *L. columbinum* Rost. Versuch, 7 (1873). Plasmodium colourless. Total height 2 to 3 mm. Sporangia gregarious, globose or ellipsoid, stalked, erect, 0.5 to 0.8 mm. diam., purplish-black with iridescent violet or green reflections, or

shining like burnished brass; sporangium-wall membranous, persistent, purplish in the lower part, usually mottled with darker shades. Stalk cylindrical, usually 1.5 mm. high, 0.15 mm. thick, purplish-black, shining, longitudinally striate or rugose, rising from a dark purplish hypothallus. Columella cylindrical with a conical apex, or clavate, reaching to more than half the height of the sporangium. Capillitium of brownish-purple threads, radiating from the columella, sparingly forked and anastomosing, towards the surface branching and forming a delicate, nearly colourless network. Spores purple-grey, closely spinulose, 11 to 14  $\mu$  diam.—Rost. Mon., p. 203; Mass. Mon., 100; Macbr. N. Am. Slime-Moulds, 141. *Physarum columbinum* Pers. Obs. Myc., i. 5 (1796); Fr. Syst. Myc., iii. 136 (1829). *P. salicinum* Schum. Enum. Pl. Saell., ii. 200 (1803)? *P. bryophilum* Fr. l.c., 135? *Stemonitis physaroides* Alb. & Schw. Consp. Fung., 103, t. 11, fig. 8 (1805)? *S. porphyra* Berk. & Curt. in Grev., ii. 69 (1873)? *Lamproderma physaroides* Rost. Mon., p. 202; Mass. l.c., 103; Lister Mycetozoa, 125; Macbr. l.c., 139. *L. Schimperii* Rost. l.c., p. 203. *L. Staszycii* Racib. in Hedw., xxviii. 116 (1889).

Var. *sessile* Lister: sporangia sessile, without columella, capillitium dark or pale.—*Physarum iridescens* Berk. in Hook. Journ. Bot., iii. 20 (1851). *Lamproderma iridescens* Rost. Mon., App. p. 25 (1876).

Pl. 131.—*a.* sporangia (England); *b. c.* sporangia (Switzerland); *d.* ellipsoid sporangia (South America); *e. f.* capillitium and columella; *g.* capillitium from lower part of sporangium; *h.* sporangia of var. *sessile* (England); *i.* capillitium of same; *k.* columellae of various shapes from one group of sporangia; *l. m.* spores.

This beautiful and widely distributed species is subject to considerable variation in the shape of both the sporangium and columella and in the length of the stalk. Spherical forms with shorter stalks sometimes occur closely resembling *L. violaceum* var. *Sauteri*, from which they may be distinguished by the capillitium threads being less intricately branched and purple in colour with hyaline tips, and by the purplish-grey spores. The type of *Stemonitis iridescens* Berk. on Hepatics from the Pyrenees (K. 1318), is the var. *sessile* of the present species; the sporangia, now broken, were globose, and either sessile or on short stalks; the capillitium is described by Rostafinski as colourless, though in a sporangium examined the few threads that remain are dark brown; the columella is absent, but the base of the sporangium is thickened by a tissue of purplish-brown interwoven bands; the spores are purple-grey as in the type. Another gathering of var. *sessile* from Norway, kindly furnished by Prof. Blytt, is on moss associated with the long stalked form of *L. columbinum*; the globose sporangia are each seated on a yellowish horny cushion of dried plasmodium; there is no stalk or columella; the capillitium rises from the broad base of the sporangium and is more rigid than that of the stalked form; the spores measure 16 to 19  $\mu$ ; in the accompanying stalked sporangia they measure 12 to 13  $\mu$ . It would seem probable that some gatherings at least of the var. *sessile* are not normal developments. Typical *L. columbinum* has occurred abundantly every autumn for some years in succession on moss on wet rocks in a wooded ravine

in North Wales; it is not unfrequently associated with *Badhamia rubiginosa* var. *globosa*, and when the sporangia of the latter are almost limeless, they can hardly be distinguished in the field from those of *L. columbinum*. Fries describes the plasmodium of both *Physarum bryophilum* and *P. columbinum* as yellow, and it is possible that his specimens may in part have been the above-mentioned form of *B. rubiginosa* which has bright lemon-yellow plasmodium. The description and illustration of *Stemonitis physaroides* Alb. & Schw., with globose shining silvery-grey sporangia and compact globular capillitium, suggest *L. arcyrionema* rather than the present species, but in the absence of the type this reference is conjectural. The specimen in the Strassburg herbarium of *L. physaroides* agrees in all respects with the above description of *L. columbinum*. There are three specimens in that collection marked by Rostafinski *L. columbinum*; one is the present species, one is a pale form of *L. violaceum*, and the third is *L. scintillans*.

*Hab.* On fir wood, moss, etc.—Leighton, Beds (B.M. slide); Gloucestershire (B.M. 204); Northumberland (B.M. 2666); Berwick (K. 1568); Cornwall (B.M. 2667); North Wales (B.M. 2668); Moffat, Scotland (B.M. slide); France (K. 628); Germany (B.M. 603); Sweden (B.M. 2669); Norway (B.M. slide); Switzerland (B.M. 2670); Japan (B.M. 2671); Massachusetts (B.M. 1403); Maine (B.M. 1611); Adirondack Mountains, New York (B.M. 2672); var. *sessile*—Leighton, Beds (B.M. 1404); Aberdeen (B.M. 2673); Pyrenees (K. 1318); Portugal (B.M. slide).

5. *L. violaceum* Rost. Versuch, 7 (1873). Plasmodium watery-white. Total height 0·6 to 1·5 mm. Sporangia stalked, rarely sessile, subglobose, more or less flattened and umbilicate beneath, or shortly ellipsoid, erect, scattered or aggregated, 0·4 to 0·9 mm. diam., shining with iridescent blue, violet or bronze reflections; sporangium-wall membranous, somewhat persistent, pale violet-brown. Stalk varying from very short to one and a half times the height of the sporangium, black, rising from a red-brown membranous hypothallus. Columella one-third to two-thirds the height of the sporangium, cylindrical, obtuse, or sometimes narrowing to the apex. Capillitium of almost colourless or brown threads springing from the upper part of the columella, branching and anastomosing to form a more or less dense network, becoming very slender towards the surface. Spores purplish-grey, minutely spinulose, 8 to 10  $\mu$  diam.—Rost. in Fuekel Symb. Fung., Nachtr. 69; Mon., p. 204; Mass. Mon., 94; Macbr. in N. Am. Slime-Moulds, 143. *Stemonitis violacea* Fr. Syst. Myc., iii. 162 (1829). *S. arcyrionides* Somm. in Mag. Nat., vii. 298 (1827). *Lamproderma arcyrionides* Rost. Mon., p. 206; Blytt in Bidr. K. Norg., Sop. iii. 8; Mass. l.c., 102. *L. nigrescens* Rost. l.c., p. 205 (1875)? *L. leucosporum* Rost. Mon., App. p. 26 (1876)? *L. minutum* Rost. l.c.? *L. nigrescens* Sacc. in Michelia, ii. 262 (1882) (non Rost.). *L. Saccardianum* Mass. l.c., 101 (1892). *Tilmadoche Berkeleyi*, Mass. l.c. 332.



Var. 1. **Sauteri** Lister: sporangia globose, or ovoid-globose; capillitium brown; spores purple-brown, 11 to 15  $\mu$  diam., nearly smooth or spinose.—*L. Sauteri* Rost. Mon., p. 205; Mass. Mon., 100; Macbr. N. Am. Slime-Moulds, 140. *L. robustum* Ellis & Everh. in Mass. l.c., 99. *L. arcyrioides* Morg. Myx. Miami Valley, 47 (1894).

Var. 2. **Carestiae** Lister: sporangia globose or ovoid, nearly black, shortly stalked or quite sessile; capillitium dark purple-brown, forming either a dense network or consisting of almost straight threads; spores purple-brown, closely spinulose or spinose, 9 to 16  $\mu$  diam.—*Stemonitis Carestiae* Ces. & de Not. Erb. Crit. Ital., no. 888.

Var. 3. **dictyosporum** Lister: resembling var. *Carestiae*, but with purplish-grey spores 10 to 14  $\mu$ , marked with spinules and short ridges more or less united to form an irregular reticulation.—Lister in Journ. Bot., xlv. 218 (1908).

Pl. 132.—*a. b.* sporangia (England); *c.* capillitium and columella; *d. e.* spores *f.* sporangium of var. *Sauteri* (Salzburg); *g. m.* spores of same; *h.* sporangia of var. *Carestiae* (North Italy); *i.* capillitium and columella of same; *k. l.* spores of same.

Pl. 133.—*f.* sporangia of var. *dictyosporum* (Switzerland); *g.* sporangia of same after dispersion of spores; *h. i.* spores.

This species is abundant in the British Isles, in Europe and in North America. The varieties given above are well-marked centres, round which intermediate forms group themselves, but neither the size of the spores, the colour of the capillitium, nor the shape of the sporangia can be taken as giving constant specific characters. The typical form appears to be usually found in the lowlands; the three varieties are essentially alpine forms. Gatherings made near Lyme Regis show great variety of capillitium; even in a single development it may be either nearly colourless and flaccid, or brown and rigid, the associated spores being pale violet-grey, closely and minutely spinulose, 8 to 10  $\mu$  diam. The original gathering on which Sommerfelt founded *S. arcyrioides*, of which through the courtesy of Prof. Blytt of Christiania a mounting is in the British Museum, has globose sporangia, with brown capillitium and nearly smooth spores 8 to 9  $\mu$  diam., as in typical *L. violaceum*. The measurement "12.5 to 16.5  $\mu$ " given by Rostafinski and repeated in other works is erroneous, but is corrected by Prof. Blytt, l.c. By the strict application of the rule of priority, the name *L. arcyrioides* should take precedence of *L. violaceum*, but the former has been so long associated with a misleading description that it would seem preferable to retain the familiar and appropriate name given by Fries. The type of *L. Sauteri* from Salzburg in the Tyrol, now in the Strassburg Herbarium, has the same form of sporangium and abundant brown capillitium as in the type of *S. arcyrioides* Somm., but has spinulose spores, 11 to 14  $\mu$  diam. The type of *Lamproderma robustum* Ellis and Everh., from Philadelphia (B.M. slide), is var. *Sauteri* with dark, strongly spinulose spores 11 to 13  $\mu$  diam.; it is almost identical with the type of *L. Sauteri*. In some gatherings of var. *Carestiae* the spores measure 9  $\mu$ , in others 11 to 14  $\mu$ , in others again 14 to 17  $\mu$ ; they are usually dark purplish-brown, and either nearly smooth or strongly spinulose. The var. *dictyosporum* is distinguished

from var. *Carestiae* by the spore markings; it appears to be abundant in the Jura Mountains and on the Swiss Alps in spring-time.\* The type of *Tilmadoche Berkeleyi* Mass., from the United States (K. 1563A), appears to be an immature specimen of *L. violaceum*.

*Hab.* On dead leaves, twigs and herbaceous stems.—Twycross, Leicester (B.M. 203B); Brockley, Somerset (B.M. 202); Devon (B.M. 1412); Luton Hoo, Beds (B.M. 1411); Cornwall (B.M. 2675); Salop (B.M. 2674); Alnwick, Northumberland (B.M. 2676); North Wales (B.M. 2677); Scotland (B.M. 2678); France (Paris Herb.); Germany (Strassb. Herb.); Switzerland (Strassb. Herb.); Norway (B.M. slide); Portugal (B.M. 2679); Maine (B.M. 1610); Massachusetts (B.M. 1413); Ohio (B.M. 2680); Iowa (B.M. 2681); West Virginia (B.M. 1919); var. *Sauteri*—Tyrol (B.M. slide); Germany (B.M. 607B); Switzerland (B.M. 2682); Philadelphia (B.M. slide); var. *Carestiae*—Clova, Scotland (B.M. 2683); Sweden (B.M. 2684); Germany (B.M. 607A); Switzerland (B.M. 608); North Italy (B.M. 606); Philadelphia (B.M. 1806); var. *dictyosporum*—Switzerland (B.M. 2686).

6. *L. Lycopodii* Raunkiaer in Bot. Tidssk., xvii. 109 (1888). Plasmodium? Sporangia scattered or clustered, globose, 0.8 mm. diam., stalked, sessile, or forming plasmodiocarps, purple-brown, shining with iridescent colours; sporangium-wall membranous, colourless above, purplish-brown below. Stalk black, 0.2 to 0.5 mm. high. Columella cylindrical, reaching to half or two-thirds the height of the sporangium, absent in the plasmodiocarp form. Capillitium a network of pale purplish-brown flexuose threads, which are stouter below, slender and colourless at the tips. Spores brownish-purple, 12 to 18  $\mu$  diam., regularly reticulated with narrow raised bands that form a net with from 14 to 24 meshes on the hemisphere, and show as a border 1 to 1.5  $\mu$  wide.—Lister in Journ. Bot., xlvii. 218. *Stemonitis cribrarioides* Fr. Syst. Myc., iii. 163 (1829)? *Cribraria Lycopodii* F. Nees in litt. ex Fr. l.c.?

Pl. 133.—a. plasmodiocarp (Switzerland); b. c. capillitium; d. e. spores.

This species is closely allied to *L. violaceum* var. *dictyosporum* from which it differs in the perfectly reticulated and bordered spores, and paler capillitium. Besides the type from Zealand two other gatherings have been obtained—a plasmodiocarp form on *Lycopodium alpinum* found by Dr. A. Volkart on the Fürstenalp, Graubünden, 1,700 m. alt., and a specimen with stalked sporangia, on a twig, gathered by G. von Beck on the Alps near Vaduz, Lichtenstein,

\* M. Ch. Meylan has recently published a new species, *Lamproderma atroporum* (Bull. Soc. Vaud., xlvii. 51) which is distinguished by the following characters. The sporangium-wall is either completely evanescent or adheres in fragments to the dark tips of the capillitium; 'he latter resembles that of *L. violaceum* var. *Carestiae*; the spores are black in mass, and either spinulose or marked with a close irregular network of ridges. Under this species he would include *L. violaceum* var. *dictyosporum*, and some gatherings classed hitherto as *L. violaceum* var. *Carestiae* from which he considers *L. atroporum* always differs in having blacker spores and more fragmentary sporangium-walls. In correspondence he writes that while *L. violaceum* together with the vars. *Sauteri* and *Carestiae* are of frequent occurrence on the Jura Mountains and blend freely into one another, he has never found forms connecting these with *L. atroporum* which occurs in similar situations and is also abundant.

at an altitude between 1,600 and 1,700 m. *Stemonitis cribrarioides* Fr. is quoted by Prof. Raunkiaer as a possible synonym for the present species, but in the absence of the type this determination must remain conjectural.

*Hab.* On *Lycopodium* and dead twigs.—Graubunden, Switzerland (B.M. slide); Lichtenstein, Austria (B.M. 2687).

Genus 22.—**CLASTODERMA** Blytt in Bot. Zeit., xxxviii. 343 (1880). Sporangia stalked, without lime; columella very short or hardly evident; capillitium arising from the apex of the columella as solid lilac or ochraceous threads, repeatedly forking, sparingly anastomosing; sporangium-wall dividing into subhyaline membranous, rounded or sub-polygonal fragments, attached to one or from two to five of the ultimate branches of the capillitium; spores pale brown.—*ORTHOTRICHIA* Wingate in Journ. Myc., ii. 125 (1886).

1. **C. Debaryanum** Blytt l.c. Plasmodium? Total height 1 to 1.25 mm. Sporangia gregarious, globose, stalked, 0.15 to 0.2 mm. diam., brown; sporangium-wall membranous, persistent only in circular or polygonal plates attached to the ultimate branches of the capillitium. Stalks slender, rugose below, suddenly smooth and filiform in the upper fifth, brown. Columella short, dividing into the primary branches of the capillitium. Capillitium of pale brown threads, forking three or four times, sparingly anastomosing at the surface or free, the ultimate branches attached singly or two or three together to the membranous plates of the sporangium-wall. Spores pale brown, smooth, 7 to 10  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 138. *Orthotrichia microcephala* Wing. l.c.; Mass. Mon., 109.

Pl. 135.—*a.* sporangia (Philadelphia); *b.* sporangia after dispersion of spores; *c.* capillitium branches; *d.* capillitium with expanded membranous plates (Norway); *e.* spore; *f.* sporangium (Norway); *g.* spore (Ceylon).

This species was discovered by Prof. Blytt in 1879, near Christiania, growing on dead *Polyporus*. In the United States it has been repeatedly found, and was described by Mr. Wingate as *Orthotrichia microcephala*. In these gatherings the threads anastomose more freely than in the Norwegian specimen, and the disc-shaped fragments of the sporangium-wall are usually less pronounced; in some sporangia, however, they agree essentially with the type kindly submitted for examination by Prof. Blytt, and it cannot be doubted that they are the same species. Mr. Petch describes *Clastoderma Debaryanum* as being rather common in Ceylon "on rotten wood in up-country jungles," but found also at lower elevations (see Petch in Ann. Perad., iv. 354).

*Hab.* On dead wood.—Norway (Christiania Herb.); Sweden (B.M. 2688); Austria (B.M. 2689); Portugal (B.M. 2690); Ceylon (B.M. 2691); Borneo (B.M. slide); Japan (B.M. 2692); Philadelphia (B.M. 874).

Genus 23.—**ECHINOSTELIUM** de Bary in Rost. Versuch, 7 (1873). Sporangia stalked, very minute,  $50\ \mu$  diam., colourless; capillitium branches few, arising from the apex of a short columella.\*

1. *E. minutum* de Bary l.c. Plasmodium colourless. Sporangia scattered, stalked, colourless, globose, 40 to  $50\ \mu$  diam. Sporangium-wall persistent at the base as a minute collar. Stalk setaceous, narrowed upwards, 0.4 mm. long, hyaline, enclosing nearly colourless refuse matter. Columella slender, 3 to  $4\ \mu$  high. Capillitium of two or three colourless zigzag threads, simple or sparingly branched and anastomosing, with free spine-like branches. Spores colourless, smooth,  $6\ \mu$  diam.—Rost. Mon., p. 215, figs. 53, 54, 58, 68; Mass. Mon., 109.

Pl. 128.—*f.* sporangia (Dumfriesshire); *g.* sporangium showing capillitium; all the spores but two are dispersed; *h.* various forms of capillitium; *i.* spores.

This inconspicuous species appears to be most nearly allied to *Glastoderma Debaryanum*. It may be easily mistaken for the fruit of a *Mucor*, which it superficially resembles. The only British gatherings recorded are two made by Miss A. L. Smith who found it on dead wood in Dumfriesshire, and also in Herefordshire. The spore has not a perfectly uniform wall, but is divided into areolae by thin lines of dehiscence.

*Hab.* On dead wood.—Hereford (B.M. slide); Austria (B.M. slide.)

## Order II.—AMAUROCHAETACEAE.

Sporangia combined into an aethalium. Capillitium dark purple-brown, of irregular strands and threads, or of complex structure.

KEY TO THE GENERA OF AMAUROCHAETACEAE.  
Capillitium of irregularly branching threads.

(24) AMAUROCHAETE.

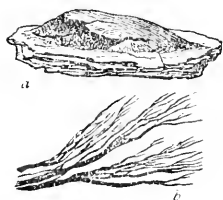


Fig. 32.—*Amaurochaete fuliginosa* Macbr.

a. Aethalium. Half natural size.

b. Capillitium. Magnified 10 times.

Fig. 32.

\* *Heimerlia hyalina* F. v. Höhnelt (Ann. Myc. i., 391 (1903)), which has by some writers been included among the Mycetozoa, does not appear to belong to this group. Very little is known of its life history. The minute colourless sporangia somewhat resemble those of *Echinostelium minutum* in size and shape. The slender subulate stalk penetrates the sporangium to form a long columella; there is no capillitium; the spores are held together by a drop of hyaline nuclage; they do not give rise to amoeboid bodies, but the contents consist of a long closely coiled thread; when placed in water the spore-wall bursts and the thread rapidly straightens into a non-motile rod 70 to  $80\ \mu$  long,  $0.2\ \mu$  wide. These observations were made on specimens that appeared on dead wood at Lyme Regis in July, 1904: the further fate of the threads was not traced. It appears possible that *Endodromia vitrea* Berk. (Hook. Journ. Bot., lii. 78, t. 1, f. c. (1841)) is the same species.

Capillitium of horizontal threads, with many chambered vesicles.

## (25) BREFELDIA

Fig. 33.—*Brefeldia maxima* Rost.

a. Aethalium. Natural size.

b. Capillitium and spores. Magnified 50 times.

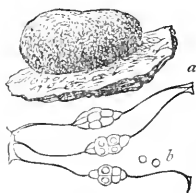


Fig. 33.

Genus 24.—**AMAUROCHAETE** Rostafinski Versuch, 8 (1873). Aethalium pulvinate, composed of elongated closely compacted confluent sporangia; sporangium-walls not developed within the aethalium. Capillitium radiating from the broad membranous base, consisting of numerous erect dark purple-brown irregularly flattened ragged strands, dividing into many anastomosing branches, which vary much in length, thickness and regularity.

This genus appears to be closely allied to *Stemonitis*.

1. *A. fuliginosa* Macbr. N. Am. Slime-Moulds, 109 (1899). Plasmodium creamy-white. Aethalium pulvinate or variously shaped, 2 mm. to 4 cm. or more broad, black, covered with a silvery fragile cortical membrane; individual sporangium-walls undeveloped. Capillitium as described in the genus, often scanty. Spores dull purple, paler on one side, spinulose, 11 to 13  $\mu$  diam.—*Lycoperdon fuliginosum* Sow. Engl. Fung., t. 257, with description (1803). *Lycogala atrum* Alb. & Schw. Consp. Fung., 83 (1805). *Demordium inquinans* Link in Mag. Ges. Nat. Fr. Berl., iii. 25 (1809)? *Strongylium majus* Fr. Symb. Gast., 9 (1817). *Lachnobolus cribrosus* Fr. Syst. Orb. Veg., 148 (1825)? *Reticularia atra* Fr. Syst. Myc., iii. 86 (1829). *Amaurochaete atra* Rost. Versuch, 8 (1873); Mon., p. 211; Mass. Mon., 89; Lister Mycetozoa, 134.

Pl. 136.—a. capillitium (England); b. c. spores.

Sowerby's illustration of *Lycoperdon fuliginosum* with the accompanying note so well represents the present species, that his specific name must take precedence over that of Albertini and Schweinitz which, though given later, has been usually adopted.

*Hab.* On dead coniferous wood.—Halse House, Somerset (B.M. 17); Lyme Regis (B.M. 1416); Woking, Surrey (B.M. 2693); Haslemere (B.M. 2695); Hull, Yorks (B.M. 2694); Scotland (B.M. 2696); Norway (B.M. 1417); Germany (Berlin Herb.); Poland (Strassb. Herb.); Portugal (B.M. 2697); Japan (B.M. 2698); Maine, U.S.A. (K. 800).

Genus 25.—**BREFELDIA** Rostafinski Versuch, 8 (1873). Aethalium pulvinate, consisting of subcylindrical, somewhat branched and confluent sporangia, rising from a base of spongy barren tissue, which is continued, chiefly among the lower portions of the sporangia, in irregular folds; imperfect sporangium-walls and central columellae sometimes present. Capillitium of numerous horizontal threads, uniting at the surface of the adjacent sporangia to form many-chambered vesicles.

1. **B. maxima** Rost. Versuch, 8 (1873). Plasmodium creamy white. Aethalium pulvinate, 2 to 30 cm. across, 5 to 10 mm. thick, purplish-brown, composed of elongated branching sporangia 0.3 to 0.5 mm. diam., extending upwards from the spongy basal tissue which is continued among them as irregularly branching purple-brown membranous folds; distinct rigid columellae often present. Capillitium consisting of numerous threads radiating from near the central part of the sporangium, but free from the columella; each thread expands at the boundary of the sporangium into a many-chambered vesicle, which is continued into a corresponding radial thread of the adjoining sporangium; the proximal ends of the threads are connected in clusters of three or four by a fragile membrane; the vesicles are of firm texture, often containing a spore in several of the chambers, occasionally coalescing in fewer or greater numbers to form vertical scalariform strands. Spores purplish-brown, minutely spinulose, 9 to 12  $\mu$  diam.—Rost. Mon., p. 213; Mass. Mon., 91; Macbr. N. Am. Slime-Moulds, 110. *Dermodium inquinans* Fr. Symb. Gast. 9 (1817)? *Reticularia maxima* Fr. Syst. Orb. Veg., i. 147 (1825). *Licea perreptans* Berk. in Gard. Chron., 1848, 451.

Pl. 136.—*d.* subdiagrammatic view of portions of four columnar sporangia from an aethalium; each sporangium has a central columella, and is clothed on the surface with numerous vesicles, from which short capillitium threads pass into the adjacent sporangia; at *x.* is seen a scalariform strand, formed by vertical union of a row of vesicles; *e.* capillitium threads and vesicles; *f.* spores (England).

The complex structure of the capillitium is difficult to follow in the lower part of an aethalium; towards the surface the sporangia are often separated from each other by narrow intervals. The sides of the sporangia are then seen to glitter with the numberless vesicles of the capillitium. The threads penetrate the adjacent sporangia to the distance of 0.07 to 0.1 mm., or about half the radius. The entire length of the threads, including the central vesicle, is 0.15 to 0.23 mm. The mass of spores in the central part of the sporangium is not traversed by any threads. In the lower strata the threads are sometimes attached at each extremity to folds of the membrane arising from the spongy base; the rigid columellae, throughout the upper part at least, appear to be free from the capillitium. The plasmodia are sometimes very large, and may wander from the place of emergence to mature into aethalia one or two feet in length. In the field this species often shows considerable resemblance to the confluent form of a *Stemonitis*, a genus to which *Brefeldia* appears to be nearly allied.

*Hab.* On dead wood, etc.—Lyme Regis, (B.M. 2699); Darenth, Kent (B.M. 1110); Wanstead, Essex (B.M. 2700); Luton, Beds (B.M. 1418A); Birmingham (B.M. 1418); Boynton, Yorks (B.M. 1159); France (Paris Herb.); Sweden (K. 781); Germany (B.M. 2249); Switzerland (Hb. Zürich); Mass., U.S.A. (B.M. 1419); Iowa (B.M. 1020).

## Cohort II.—*LAMPROSPORALES*.

Spores variously coloured, not violet-brown or purplish-grey, except in *Licea minima* and *Listerella*, q.v.

### Subcohort I.—*ANEMINEAE*.

Capillitium absent or not forming a system of uniform threads, except in *Alwisia*, q.v.

### Order I.—*HETERODERMACEAE*.

Sporangium-wall membranous, studded with microscopic round granules (plasmodic granules), either continuous or forming a net in the upper part; capillitium wanting; spores 4 to 7  $\mu$  diam.

#### KEY TO THE GENERA OF *HETERODERMACEAE*.

Sporangia sessile, compacted or aethalioid, the wall not forming a net in the upper part. (26) *LINDBLADIA*.

Fig. 34.—*Lindbladia effusa* Rost.

a. Aethalium. Natural size.

b. Vertical section of aethalium. Magnified 6 times.

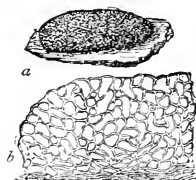


Fig. 34.

Sporangia stalked; sporangium-wall with thickenings in the form of a delicate persistent net expanded at the nodes.

(27) *CRIBRARIA*.

Fig. 35.—*Cribraria aurantiaca* Schrad.

a. Group of sporangia. Twice natural size.

b. Sporangium after dispersion of the spores. Magnified 20 times.

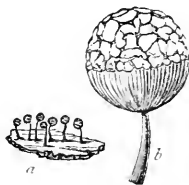


Fig. 35.

Sporangia stalked; sporangium-wall with thickenings in the form of nearly parallel ribs extending from the base to the apex, connected by delicate threads. (28) *DICTYDIUM*.

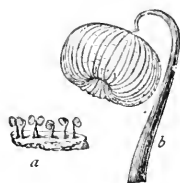


Fig. 36.

Fig. 36.—*Dictydium cancellatum* Macbr.

a. Group of sporangia. Twice natural size.

b. Sporangium after the dispersion of spores. Magnified 20 times.

Genus 26.—**LINDBLADIA** Fries Summa Veg. Scand., 449 (1849). Sporangia either combined to form an aethalium, or closely compacted; rarely free, sessile, or stalked; sporangium-wall membranous, uniform, studded with microscopic dark plasmodic granules.

1. *L. effusa* Rost. Mon., p. 223 (1875). Plasmodium blackish. Sporangia minute, combined to form a more or less complex, effused or pulvinate aethalium, 2 to 10 mm. thick, either black with a cortex of imperfectly developed spores, or umber-brown and the surface formed by the membranous walls of the convex summits of the component sporangia; hypothallus strongly developed, of membranous, more or less spongy tissue; sporangium-wall entire or perforated, membranous, yellow-brown, uniform, studded with scattered clusters of dark round plasmodic granules,  $1\mu$  diam. Spores ochraceous-brown, faintly warted, 4 to  $6\mu$  diam.—Macbr. N. Am. Slime-Moulds, 154. *Licea effusa* Ehrenb. Sylv. Myc. Berol., 26 (1818). *Lindbladia Tubulina* Fr. Summ. Veg. Scand., 449 (1849); Lister Mycetozoa, 137. *Aethalium atrum* Preuss in Linnaea, xxiv. 141 (1851). *Tubulina effusa* Mass. Mon., 41 (1892).

Var. **simplex** Rex in Bot. Gaz., xvii. 202 (1892): sporangia shortly cylindrical, closely compacted, sessile, rarely free and shortly stalked.—*Licea spermoides* Berk. & Curt. in Grev., ii. 68 (1873). *Physarum caespitosum* Peck in Rep. N. York Mus., xxvi. 75 (1874). *Perichaena caespitosa* Peck l.c., xxxi. 57 (1879). *Tubulina spermoides* Mass. Mon., 37 (1892). *T. caespitosa* Mass. l.c., 43.

Pl. 137.—a. vertical section of part of a pulvinate aethalium; b. fragment of sporangium-wall and spores; c. closely compacted tubular sporangia, var. *simplex*; d. sessile and stalked sporangia, var. *simplex*, closely allied to *Cribraria argillacea*; e. fragment of sporangium-wall and spores of same; f. spore; (United States).

The sporangium-walls in the aethalioid form are usually continuous; some aethalia however, gathered by Mr. K. Minakata in the province of Kii, Japan, have the walls widely perforated with large rounded openings as in the genus *Enteridium*. The var. *simplex* has hitherto been recorded only from the United States and Japan; it was first described by Dr. Rex (l.c.), with a full account of the genus *Lindbladia* and of the relationship which exists between *L. effusa*



and *Cribraria argillacea*. His gatherings show a complete series of intermediate forms between the two species. *Licea spermoides* Berk. & Curt. is var. *simplex*, and is represented by several specimens in the Kew Collection, including the type from Alabama referred to by Rostafinski in his App., p. 32; he cites the name as a synonym for *Cribraria argillacea* (K. 1695), but although the sporangium-wall is studded with patches of dark plasmodic granules, there is no indication of a net to warrant its being placed under *C. argillacea*. The plasmodium of this species is described by Dr. Jahn as being "black, like cart-wheel grease."

*Hab.* On dead wood.—Bulmer, Yorks (B.M. 1420); Aspley, Beds (B.M. 2702); North Wales (B.M. 2701); Aboyne, Scotland (B.M. 244); Sweden (K. 1658); Germany (B.M. 2703); Portugal (B.M. 2704); Ceylon (B.M. 2705); Japan (B.M. 2706); Washington State (B.M. 2707); Philadelphia (B.M. 1421, A, B); Colorado (B.M. 2708); var. *simplex*—Japan (B.M. 2013); Ohio (B.M. 1421c); Iowa (B.M. 822); South Carolina (B.M. 948).

Genus 27.—**CRIBRARIA** Persoon in Roemer Neues Mag. Bot., i. 91 (1794). Sporangia globose or subpyriform, stalked; sporangium-wall persistent and forming a cup in the lower half or reduced to a basal disc, continued above as a net of slender threads more or less expanded and thickened at the nodes, membranous and evanescent in the meshes of the net.

#### KEY TO THE SPECIES OF *CRIBRARIA*.

##### A. Nodes of the net not thickened :—

- A. Sporangia clay-coloured, cup imperfectly defined, sporangium-wall subpersistent above. 1. *C. argillacea*
- B. Sporangia dull crimson, net close. 2. *C. rubiginosa*
- C. Sporangia nut-brown or rufous—
  - Sporangia 0.6 mm. diam., net lax. 3. *C. rufa*
  - Sporangia 0.1 to 0.2 mm. diam. 4. *C. minutissima*

##### B. Nodes of net thickened :—

- A. Sporangia nut-brown—
  - a. Cup ribbed, perforated at the margin, merging into the branching nodes. 5. *C. macrocarpa*
  - b. Cup well-defined, nodes usually flattened, angular, branching. 6. *C. aurantiaca*
  - c. Cup replaced by strong ribs, nodes usually flattened. 7. *C. splendens*
  - d. Cup well-defined or absent, nodes thickened, prominent, numerous—

Nodes with free rays, and connected by five to eight slender threads.

8. *C. intricata*

Nodes rounded in outline, without free rays, connected by four to five slender threads.

9. *C. tenella*

## B. Sporangia dark or red-brown—

- a. Stalk two or three times the height of the sporangium ; plasmodic granules dark, 1 to 2  $\mu$  diam.

10. *C. pyriformis*

- b. Stalk four to six times the height of the sporangium—  
Cup one-third the height of the sporangium, nodes polygonal.

11. *C. languescens*

Cup minute or absent, nodes rounded, prominent.

12. *C. microcarpa*

## c. Sporangia purple—

- Cup one-third the height of the sporangium, 0.7 mm. diam.

13. *C. purpurea*

Cup one-half of the sporangium, 0.5 mm. diam.

14. *C. elegans*

- d. Sporangia violet-blue, 0.25 mm. diam. 15. *C. violacea*

1. *C. argillacea* Pers. in Roemer N. Mag. Bot., i. 91 (1794). Plasmodium lead-coloured or purplish-olive. Total height 0.75 to 1.5 mm. Sporangia globose, crowded, stalked or nearly sessile, 0.5 to 0.8 mm. diam., when immature lilac or lead-coloured, at length clay-coloured ; cup imperfectly defined ; sporangium-wall subpersistent throughout, delicately membranous above, stouter towards the base, reticulated with strongly or faintly thickened bands, which are studded with dark plasmodic granules 1  $\mu$  diam., and form a net with hardly expanded nodes and subquadrangular meshes about 0.1 mm. wide. Stalk cylindrical, 0.1 to 0.8 mm. high, furrowed, dark brown, arising from a well-developed hypothallus. Spores ochraceous, nearly smooth, 5 to 6  $\mu$  diam.—Rost. Mon., p. 238 ; Mass. Mon., 65 ; Machr. N. Am. Slime-Moulds, 161. *Stemonitis argillacea* Pers. in Gmel. Syst. Nat., ii. 1469 (1791). *S. sphaerocarpa* Schrank in Roem. & Ust. Mag. Bot., xii. 20 (1790) ? *Cribraria micropus* Schrad. Nov. Gen. Pl., 3 (1797). *Licea brunnea* Preuss in Linnaea, xxvi. 709 (1853) ?

Pl. 138.—a. sporangia (England) ; b. net of sporangium-wall and stalk ; c. spores and plasmodic granules ; d. spores.

This species varies much in the extent to which the net of the sporangium-wall is developed. In the usual form the bands are dark brown, well-defined, hardly expanded at the nodes, often stouter towards the base ; but in some gatherings the thickenings are faint and broad, and the wall of the sporangium is nearly uniform in texture, in which case it closely resembles the var. *simplex* of *Lindbladia effusa*.

*Hab.* On dead wood : common in Europe and the British Isles.—Richmond, Surrey (B.M. 1422) ; Birmingham (B.M. 1424) ; Leighton, Beds (B.M. 1423) ; Boynton, Yorks (B.M. 1044) ; North Wales (B.M. 2709) ; Aboyne, Scotland (B.M. 243) ; Ireland (B.M. 2712) ; France (B.M. 2713) ; Germany (B.M. 2267) ; Norway (Herb. Christiania) ;

Switzerland (B.M. 2711); Portugal (B.M. 2710); New England (B.M. 1425); Philadelphia (B.M. slide); Washington State (B.M. 2714); Colorado (B.M. 2715).

2. *C. rubiginosa* Fries Syst. Myc., iii. 172 (1829). Plasmodium purple-black. Total height 2 to 4 mm. Sporangia in large clusters, ellipsoid or subglobose, stalked, erect, 1 to 1.7 mm. high, 1 to 1.5 mm. broad, dull crimson; cup one-third to half the height of the sporangium, ill-defined above, marked with numerous oblique or longitudinal ribs, or with a close reticulation of thickened bands, and studded with plasmodic granules 1 to 1.5  $\mu$  diam.; net of slender red-brown rigid threads with a mesh about 0.1 mm. diam., without conspicuous expansions at the nodes. Stalk rugged, dark brown, 0.3 to 2 mm. long, 0.2 mm. thick. Spores rufous, almost smooth, 5 to 6  $\mu$  diam.—Meylan in Bull. Soc. Vaud., xliv. 294 (1908).

Pl. 139.—*a.* sporangia (Sweden); *b.* sporangium after dispersion of spores, from a mounting in Canada Balsam; *c.* part of net of sporangium-wall with margin of cup; *d.* *e.* spores.

This handsome species is allied to *C. macrocarpa*, but differs in the ruddy colour of the spores, and in the less expanded nodes of the sporangial net. M. Meylan finds in the Jura mountains a form with stalks two and even three millimetres long which he has published as var. *longipes* (l.c.); he states that it only appears in the autumn months.

*Hab.* On dead wood, etc.—Sweden (B.M. slide); Berne, Switzerland (B.M. 2716); Jura Mountains (B.M. 2717).

3. *C. rufa* Rost. Mon., p. 232 (1875). Plasmodium milk-white. Total height 1.5 to 2 mm. Sporangia scattered, stalked, subglobose or turbinate, erect, 0.6 to 0.7 mm. diam., bright orange-red; cup one-third the height of the sporangium, with a regularly toothed margin, more or less ribbed, the thicker ribs continued into the wide-meshed net; the plasmodic granules of the sporangium-wall hardly 1  $\mu$  diam.; nodes of the net not expanded, or narrow, triangular and flattened, connected by three or four firm threads. Stalk cylindrical, the length of the sporangium or more, 0.2 mm. thick, longitudinally rugose, black. Spores pale yellowish-red, minutely warted, 5 to 8  $\mu$  diam.—Mass. Mon., 63. *Stemonitis rufa* Roth Fl. Germ., i. 548 (1788). *Cribraria rufescens* Pers. in Roemer N. Mag. Bot., i. 91 (1794); Lister Mycetozoa, 140. *C. intermedia* Schrad. Nov. Gen. Pl., 4 (1797). *C. fulva* Schrad. l.c., 5.

Pl. 140.—*a.* sporangia (Scotland); *b.* net and cup of sporangium-wall; *c.* spore and plasmodic-granules.

This well-marked species is remarkably constant in its characters; it appears to be most nearly allied to *C. minutissima*, from which it differs in its much larger proportions.

*Hab.* On dead coniferous wood.—Witley, Surrey (B.M. 2718) Woburn Sands, Beds (B.M. 2719); Derbyshire (B.M. 2724); North

Wales (B.M. 2720); Moffat, Scotland (B.M. 1427); Sweden (B.M. 2722); Germany (B.M. 2231); Switzerland (B.M. 2721); Bohemia (B.M. 2723); Washington State (B.M. 2725).

4. *C. minutissima* Schwein. in Trans. Amer. Phil. Soc., n.s. iv. 260 (1832). Plasmodium? Total height 0.5 to 0.7 mm. Sporangia stalked, gregarious, globose, erect or inclined, 0.1 to 0.2 mm. diam., nut-brown; cup either about half the height of the sporangium, or entirely wanting, pale nut-brown, nearly even at the margin, faintly striate longitudinally with lines of plasmodic granules  $1\ \mu$  diam.; nodes of the net not expanded, or narrow and flattened, connected by three to five delicate threads. Stalk filiform, one and a half to four times the height of the sporangium, brown. Spores ochraceous, minutely spinulose, 5 to  $6.5\ \mu$ .—Rost. Mon., App. p. 31; Macbr. N. Am. Slime-Moulds, 162. *Cribraria minima* Berk. & Curt. in Grev., ii. 67 (1873); Mass. Mon., 59. *C. microscopica* Berk. & Curt. l.c.; Rost. l.c.; Mass. Mon., 62.

Pl. 140.—*d.* to *g.* sporangia after dispersion of spores; *h.* spore and plasmodic granules; (United States).

In the large gatherings obtained by Dr. Rex of this minute species, great variety is found in the size of the cup and in the extent to which nodes of the net are enlarged. Nothing now remains in this country of the type specimen of *C. microscopica* Berk. & Curt.; but from Berkeley's description and figure it differs from the present species only in having the nodes of the net rather widely expanded, a character so variable that *C. microscopica* is here included under *C. minutissima*. The type of *C. minima* Berk., from South Carolina (B.M. 671) is the form of the present species having a deep cup; the nodes of the net are either triangular or unexpanded.

*Hab.* On dead wood.—Ceylon (B.M. 2726); South Carolina (B.M. 671); Philadelphia (B.M. 2728); Colorado (B.M. 2727).

5. *C. macrocarpa* Schrad. Nov. Gen. Pl., 8 (1797). Plasmodium slate-coloured. Total height 2 mm. Sporangia stalked, gregarious or scattered, globose or turbinate, erect, 0.6 to 1 mm. diam., rufous-brown; cup about one-third of the sporangium, orange-brown, with numerous dark longitudinal ribs, perforated above, irregularly and deeply toothed at the margin and merging into the branching nodes of the net; nodes flattened, elongated, confluent and irregular in the lower part, branching and polygonal with the angles continued into the connecting threads above; the nodes and ribs of the cup studded with dark plasmodic granules 1 to  $2\ \mu$  diam. Stalk 0.8 to 1 mm. high, 0.1 mm. thick, furrowed, dark brown. Spores ochraceous, nearly smooth, 4 to  $6\ \mu$  diam.—Rost. Mon., p. 238; Mass. Mon., 56; Macbr. N. Am. Slime-moulds, 162. *C. tatarica* Racib. in Hedw., xxiv. 170 (1885) *Heterodictyon Bieniaszii* Racib. in Hedw., xxviii. 121 (1889).

Pl. 141.—*a*, sporangia after dispersion of spores; *b*, part of net and cup of sporangium (Freiburg, Germany, specimen named by Rostafinski); *c*, net and cup of sporangium (Black Forest, Germany); *d*, spore, and plasmodic granules.

Specimens from America from low elevations have usually more numerous and slender connecting threads and more prominent nodes in the upper part of the net; they approach forms of *C. intricata*, while the European type is coarser and more nearly resembles bold forms of *C. aurantiaca*. A gathering made by Dr. Rex at an elevation of 6,200 feet on Roan Mount, North Carolina, exactly corresponds with the specimen named by Rostafinski in the Strassburg collection.

*Hab.* On dead coniferous wood.—Glamis, Scotland (K. 1677); Germany (B.M. slide); Norway (B.M. slide); Switzerland (B.M. 2729); New York (B.M. 1429); New Hants (B.M. slide).

6. *C. aurantiaca* Schrad. Nov. Gen. Pl., 5 (1797). Plasmodium sap-green or slate-grey. Total height 1 to 2 mm. Sporangia gregarious, stalked, globose, erect or nodding, 0.4 to 0.7 mm. diam., nut-brown; cup one-third the height of the sporangium, irregularly and deeply toothed at the margin, studded with round plasmodic granules 0.5 to 1  $\mu$  diam. arranged in close lines radiating from the base of the sporangium; nodes of the net flattened, broad, branching and angular, or narrow, the angles continued into the slender connecting threads and often into a few free rays. Stalk subulate, dark brown, two to four times the height of the sporangium. Spores golden-yellow or ochraceous, smooth, 5 to 6  $\mu$  diam.—Rost. Mon., p. 233; Mass. Mon., 57; Macbr. N. Am. Slime-Moulds, 164. *C. vulgaris* Schrad. l.c., 6; Rost. Mon., p. 234; Mass. Mon., 61. *C. vulgaris* var. *aurantiaca* Pers. Syn. Fung., 194 (1801). *C. variabilis* Ficin. & Schub. Fl. Dresden, ii. 296 (1823)? *C. intermedia* Berk. in Sm. Engl. Fl., v., pt. 2, 318 (1836).

Form  $\alpha$ . Stalk one and a half times the height of the sporangium; nodes broad, polygonal.

Form  $\beta$ . Stalk two to four times the height of the sporangium; nodes triangular, narrow.

Pl. 142.—*a*, to *c*, sporangia of various forms, with spores dispersed; *d*, part of net and margin of cup of sporangium of form *a*; *e*, part of net and margin of cup of form  $\beta$ ; *f*, *g*, spores and plasmodic granules; (England).

Rostafinski's specimens of *C. vulgaris* in Strassb. Herb., differ in no respect from those he has named *C. aurantiaca*. In describing three forms of *C. vulgaris*, " $\alpha$  genuina,  $\beta$  aurantioides,  $\gamma$  delicatula," he recognises the great variability to which the species is subject, and points out how closely his form  $\beta$  approaches *C. aurantiaca*. Gatherings of *C. aurantiaca* at Lyme Regis, from the same fir log in consecutive years, show variations in the cup, net, and colour, which illustrate the characters given in Rostafinski's description and figures of both *C. aurantiaca* and *C. vulgaris*; the latter name is therefore placed here as a synonym for the comprehensive species *C. aurantiaca*. As a rule the shorter stalked sporangia have more expanded nodes. Intermediate forms occur connecting *C. aurantiaca* with a group of allied species; a large form having a strongly ribbed cup

approaches *C. macrocarpa*; when the nodes and cup have dense deposits of dark plasmodic granules, the form approaches *C. pyriformis*; when the cup is shallow and is connected with the net by ribs, it may resemble *C. splendens*, while the forms with a close and regular net approach *C. tenella* or *C. intricata*.

*Hab.* On dead wood. Common in Europe.—Lyne Regis, Dorset (B.M. 1430); Luton, Beds (B.M. 1431); Witley, Surrey (B.M. 2730); Norfolk (B.M. 2731); Glamis, Scotland (B.M. 246); France (B.M. 2732); Germany (B.M. 673); Sweden (B.M. 2734); Poland (Strassb. Herb.); Switzerland (B.M. 2733); Austria (B.M. 1832); Portugal (B.M. 2735); Japan (B.M. 2736); Philadelphia (B.M. slide); Colorado (B.M. 2737).

7. *C. splendens* Pers. Syn. Fung., 191 (1801). Plasmodium? Total height 1.5 mm. Sporangia globose, stalked, erect or inclined, scattered, 0.3 mm. diam., nut-brown; sporangium-wall consisting in the lower half of about nine free ribs with little trace of a persistent cup, continued into a loose net with small often triangular nodes. Stalk slender, brown, four or five times the length of the sporangium. Spores pale ochre, almost smooth, 5  $\mu$  diam.—Rost. Mon., p. 236; Mass. Mon., 64; Macbr. N. Am. Slime-Moulds, 164. *Dictydium splendens* Schrad. Nov. Gen. Pl., p. 14 (1797).

Pl. 141.—*e.* sporangium after dispersion of spores (Germany; specimen named by Rostafinski); *f.* part of net of sporangium; *g.* sporangium (Switzerland); *h.* spores and plasmodic granules.

The description given above is taken from a specimen named by Rostafinski in the Strassb. Herb., from the Feldberg near Freiburg. *C. splendens* differs from *C. aurantiaca* in having strong ribs taking the place of a hemispherical cup. The persistent shining wall between the net mentioned by Rostafinski has almost disappeared in this somewhat injured specimen, but as the permanence of the membrane is met with occasionally in nearly every species of *Cribraria*, the character is not of great value. *C. splendens* appears to be connected by intermediate forms with *C. aurantiaca*, *C. intricata* and *C. tenella*. M. Meylan finds a beautiful form in the Jura Mountains with the nodes little or not at all expanded; it somewhat resembles *C. minutissima*, from which it differs in the larger size and in the strong ribs at the base of the sporangium.

*Hab.* On dead wood.—Feldberg, Germany (B.M. slide); Switzerland (B.M. 2738); Japan (B.M. 2739); Toronto, Canada (B.M. 2740); Washington State (B.M. slide); Philadelphia (B.M. slide).

8. *C. intricata* Schrad. Nov. Gen. Pl., 7 (1797). Plasmodium? Total height 1.5 to 3 mm. Sporangia gregarious, stalked, globose, nodding or erect, 0.5 to 0.7 mm. diam., ochraceous-brown; cup one-third the height of the sporangium, yellow-brown, studded with brown plasmodic granules 0.5 to 2  $\mu$  diam. arranged in close lines radiating from the base of the sporangium; margin more or less irregularly toothed; net close, regular; nodes numerous, dark brown, thickened, prominent, polygonal, often branching, with many free rays,

and connected by five to eight very slender threads. Stalk subulate, two to four times the height of the sporangium, dark brown. Spores ochraceous, nearly smooth or faintly warted, 5 to 6  $\mu$  diam.—Rost. Mon., p. 237; Mass. Mon., 59; Macbr. N. Am. Slime-Moulds, 166. *C. dictydioides* Macbr. l.c., 165, in part.

Var. *dictydioides* Lister: cup almost or quite obsolete; the nodes in the lower part of the net elongated and confluent, forming ribs converging to the apex of the stalk.—*Cribraria dictydioides* Cooke & Balf. in Rav. N. Amer. Fung., no. 475; Mass. Mon., 65; Macbr. N. Am. Slime-Moulds, 165.

Pl. 143.—*a, b.* sporangia after dispersion of spores; *c.* part of net and cup of sporangium (Borneo); *d.* sporangium after dispersion of spores, var. *dictydioides* (South Carolina; type of *C. dictydioides* Cooke & Balf.); *e.* spore and plasmodic granules.

This species is abundant in the United States and in the warmer parts of the world; it appears to be less frequent in Europe, and the typical form has only been met with in hot-houses in the British Isles; forms intermediate between *C. intricata* and *C. aurantiaca* are however not uncommon in England. The specimens in the Strassburg and Kew Herbaria marked *Cribraria Balfourii* de Bary, K. 963, 1673, on Sphagnum from the hot-houses of the Royal Botanic Gardens, Edinburgh, are small developments of the var. *dictydioides*. A nearly similar form has been obtained in orchid-houses at Lamberhurst, Kent, and at Clevedon, Somerset. The last named specimen is quoted by Mr. Massee as *C. microcarpa* (l.c., 64).

*Hab.* On dead wood.—Lamberhurst (B.M. slide); Clevedon (B.M. slide); Switzerland (B.M. 2741); Italy (B.M. 1948); Ceylon (B.M. 2742); New Zealand (B.M. 2743); Java (B.M. 1107); Borneo (B.M. slide); Japan (B.M. 2014); Philadelphia (B.M. 1872); Brazil (B.M. 2744); South Carolina (B.M. 677).

9. *C. tenella* Schrad. Nov. Gen. Pl., 6 (1797). Sporangia closely resembling *C. intricata* in size, shape, colour, and spores; cup one-third the height of the sporangium, or more or less obsolete; net close, regular; nodes numerous, dark brown, rounded, rarely elongated, prominent, with few or no free rays, connected by three to six very slender threads.—Rost. Mon., p. 235; Mass. Mon., 58; Macbr. N. Am. Slime-Moulds, 167. *C. elata* Mass. l.c., 61.

Pl. 143.—*f.* sporangium after dispersion of spores; *g.* part of net of sporangium (Ceylon: named by Rostafinski); *h.* part of net and margin of cup (Philadelphia, *i.* spore and plasmodic granules.

Both *C. tenella* and *C. intricata* are abundant in the United States, where frequent intermediate forms occur. The specimen figured, from Ceylon (K. 1684), referred to by Rostafinski as *C. tenella* (Mon., App. p. 31), has a small cup, rounded or elongated prominent nodes, with no free rays; it is similar to the specimens received from Dr. Rox from the United States under that name; Mr. Massee regards it as a distinct species, *C. elata*. A very small neat variety of *C. tenella* with long stalks, and sporangia 0.2 to 0.3 mm. diam. with hardly any cup, has been obtained several times in the United States, and also

in the island of Dominica; it closely resembles *C. microcarpa*, but may be distinguished by the yellow-brown colour of the sporangia, and the smaller plasmodic granules hardly  $1\ \mu$  diam.

*Hab.* On dead wood.—Orchid House, Lamberhurst, Kent (B.M. slide); Witley, Surrey (B.M. 2747); Scarborough (B.M. 2746); Switzerland (B.M. 2745); Ceylon (B.M. 2748); Java (B.M. 2749); Japan (B.M. 2010); Philadelphia (B.M. 1434); Antigua (B.M. slide).

10. *C. pyriformis* Schrad. Nov. Gen. Pl., 4 (1797). Plasmodium? Total height 1 to 1.7 mm. Sporangia gregarious, turbinate or globose, stalked, 0.4 to 0.9 mm. diam., pinkish or yellowish-brown; cup about one-third the height of the sporangium, pale brownish-yellow, perforated and irregularly toothed at the margin, or equally toothed, studded with large round purple-brown plasmodic granules, 2 to  $2.5\ \mu$  diam., arranged in broad lines radiating from the base or evenly distributed; nodes of the net varying in shape and size, flat, polygonal, or triangular, often branching, some usually not expanded, charged with dark round plasmodic granules and connected by pale brownish-yellow threads. Stalk stout, 0.5 to 1.5 mm. high, dark purple-brown. Spores pale ochraceous or pinkish, almost smooth, 5 to  $6\ \mu$  diam.—Rost. Mon., p. 237; Mass. Mon., 55; Macbr. N. Am. Slime-Moulds, 166.

Var. *notabilis* Rex in litt.: sporangia globose; nodes convex and prominent, rounded or irregular; stalks slender.

Pl. 144.—*a.* sporangia after dispersion of spores; *b.* part of net and cup of sporangium (Shrewsbury, England); *c.* sporangium from mounting in Canada balsam (Germany, specimen named by Rostafinski); *d.* part of net and cup of same; *e.* sporangia after dispersion of spores, var. *notabilis*; *f. g.* part of net and cup of brown and dark-brown sporangia; *h.* spore and plasmodic granules (United States) spores.

The var. *notabilis* has been found in the United States, in Switzerland and in Portugal; it differs from typical *C. pyriformis* in the sporangia being always globose, the slender stalks, the delicate threads of the net, and in the nodes, which, though variable in shape, are usually prominent and convex: it often approaches forms of *C. tenella* and *C. intricata*. The plasmodic granules vary in abundance in different gatherings.

*Hab.* On dead wood.—Beaufort, Scotland (B.M. 2751); France (Paris Herb.); Berlin (B.M. 672); Sweden (B.M. 2753); Portugal (B.M. 2752); New Hampshire (B.M. 2754); var. *notabilis*—near Zürich (B.M. 2755); Portugal (B.M. 2756); Adirondack Mountains, New York (B.M. slide); North Carolina (B.M. slide).

11. *C. languescens* Rex in Proc. Acad. Nat. Sci. Phil., 1891, 394. Plasmodium? Total height 2.5 to 3 mm. Sporangia scattered, stalked, globose, drooping, 0.25 to 0.35 mm. diam., dull red; cup about one-third the height of the sporangium, red-brown, shining, studded with purple-brown plasmodic granules 0.3 to  $1.5\ \mu$  diam., arranged in close lines radiating from the apex of the stem; margin toothed; nodes



of the net purplish-brown, thickened, rather prominent, charged with dark granules, polygonal, with few free rays, and with slender connecting threads; meshes of the net triangular. Stalk very slender, subulate, often sinuous or wavy, dark red-brown. Spores pale red, almost smooth, 5 to 6.5  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 170. *C. cuprea* Morg. Myx. Miami Valley, 16 (1893); Macbr. l.c., 171.

Pl. 145.—*a.* sporangia after dispersion of spores; *b.* part of net and margin of cup of sporangium; *c.* spore and plasmodic granules; (United States).

This slender species somewhat resembles *C. microcarpa*, but differs in the well developed cup, and in the paler smaller plasmodic granules.

*Hab.* On dead wood.—Austria (B.M. slide); Japan (B.M. 2757); Ceylon (B.M. slide); Antigua (B.M. 1678); Santa Cruz, West Indies (B.M. slide); New York (B.M. slide); Ohio (B.M. slide); South Carolina (B.M. slide).

12. *C. microcarpa* Pers. Syn., 190 (1801). Plasmodium? Total height 0.7 to 2 mm. Sporangia gregarious, globose, stalked, erect or nodding, 0.1 to 0.3 mm. diam., purplish-red; cup rudimentary or wanting; net close, regular; nodes of the net subglobose, prominent, about 10  $\mu$  diam., densely charged with usually very dark purple-brown plasmodic granules 1 to 2  $\mu$  diam., connected by five or six slender pink threads. Stalks slender, four to ten times the height of the sporangium, purple-brown. Spores pale red, minutely spinulose, 5 to 6  $\mu$  diam.—Rost. Mon., p. 235; Mass. Mon., 63; Macbr. N. Am. Slime-Moulds, 168? Petch in Ann. Pera., iv. 356. *C. capillaris* Fr. Stirp. Femsj., 84 (1825)? *Dictydium microcarpum* Schrad. Nov. Gen. Pl., 13 (1797).

Pl. 145.—*d.* sporangia after dispersion of spores (*d.* Germany, specimen named by Rostafinski, *e.* United States); *f.* part of net with cup of sporangium (Germany); *g.* the same (United States); *h.* spore and plasmodic granules.

*Hab.* On dead wood.—France (B.M. 2758); Germany (B.M. 676); Austria (B.M. 2759); Portugal (B.M. 2760); Ceylon (B.M. 2761); Japan (B.M. 2762); Philadelphia (B.M. slide); Connecticut (B.M. 2763).

13. *C. purpurea* Schrad. Nov. Gen. Pl., 8 (1797). Plasmodium? Total height 2.5 mm. Sporangia gregarious, globose, stalked, erect or inclined, 1 mm. diam., purple; cup one-third of the sporangium, with a deeply toothed margin; net of slender threads with mesh of varying size, only a few of the nodes expanded, flat, and angular; the cup and net thickly studded with round purple plasmodic granules 2 to 2.5  $\mu$  diam. Stalk cylindrical, furrowed, 1.5 mm. long, 0.1 mm. thick, purple-black. Spores purplish, minutely warted, 5 to 6  $\mu$  diam.—Rost. Mon., p. 233; Mass. Mon., 57; Macbr. N. Am. Slime-Moulds, 169.

Pl. 146.—*a.* sporangium after dispersion of spores; *b.* part of net of same; *c.* spore and plasmodic granules; (Salzburg, Tyrol).

*Hab.* On rotten wood.—Salzburg, Tyrol (B.M. slide); Bohemia (Herb. Čelakovsky); Switzerland (B.M. slide); Norway (B.M. slide); Austria (B.M. 2764); New York (B.M. 1435); Maine (B.M. 1612).

14. *C. elegans* Berk. & Curt. in Grev., ii. 67 (1873). Plasmodium? Total height 0.7 to 1.3 mm. Sporangia gregarious, globose, stalked, erect or inclined, 0.3 to 0.4 mm. diam., red-purple; cup about half the height of the sporangium, with the margin deeply toothed and perforated; net of very slender threads connecting numerous branching flat expanded nodes; both cup and nodes thickly studded with round purple plasmodic granules 2 to 2.5  $\mu$  diam. Stalk subulate, nearly smooth, 0.6 to 1 mm. long, purple-black. Spores pale violet, almost smooth, 4 to 6  $\mu$  diam.—Rost. Mon., App. p. 31; Mass. Mon., 55; Macbr. N. Am. Slime-Moulds, 169.

Pl. 146.—*d.* sporangia after dispersion of spores; *e.* part of net and margin of cup; *f.* spore and plasmodic granules; (United States).

This species closely resembles a small form of *C. purpurea*; hitherto it has been obtained only from the United States, where, Prof. Macbride writes, it is much the commoner of the two species.

*Hab.* On dead wood.—New York (B.M. slide); S. Carolina (B.M. 675).

15. *C. violacea* Rex in Proc. Acad. Nat. Sci. Phil., 1891, 393. Plasmodium deep violet-black. Total height 0.5 to 1 mm. Sporangia gregarious, globose or ellipsoid, stalked, erect or slightly nodding, about 0.2 mm. diam., dark violet with a metallic sheen; cup varying from one-third to two-thirds the height of the sporangium or more, membranous, violet-blue, the margin scalloped with few short teeth; net of slender threads connected with broadly expanded, flat, angular nodes; “exceptionally the apical portion is nearly entire, being simply perforated with three or four oval or rounded openings” (Rex); the cup and nodes are studded with purple plasmodic granules 0.5 to 1  $\mu$  diam. Stalk slender, subulate, violet-black. Spores lilac, minutely and closely warted, 6 to 8  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 168.

Pl. 146.—*g.* sporangium after dispersion of spores (England); *h.* part of net and margin of cup of same; *i.* sporangia after dispersion of spores (United States); *k.* part of net and cup of same; spore and plasmodic granules.

This minute and widely distributed species differs from *C. elegans* in the longer stalks, the smaller sporangia of a blue-, not red-purple, colour, and in the larger spores.

*Hab.* On dead wood of beech, poplar, etc.—Ivinghoe, Bucks (B.M. 1436); near Lyme Regis, Dorset (B.M. slide); Aberdeen (B.M. slide); Berlin (B.M. 2765); Austria (B.M. slide); Cameroons, West Africa (B.M. 2766); Ceylon (B.M. 2767); Japan (B.M. slide); Philadelphia (B.M. slide); Colorado (B.M. 2768); Antigua (B.M. 1679).

*C. stellata* Schum., *C. didermoides* Schum., *C. badia* Chev., are discarded by Rostafinski on what appear to be sufficient grounds.

Genus 28.—**DICTYDIUM** Schrader Nov. Gen. Pl., 11 (1779). Sporangia globose, stalked; sporangium-wall formed of parallel ribs extending from the base nearly to the apex, connected by slender transverse threads, the intervening wall evanescent or persistent only as a shallow cup.

1. **D. cancellatum** Macbr. N. Am. Slime-Moulds, 172 (1899). Plasmodium purple-black. Total height 1 to 2 mm. Sporangia gregarious, globose, usually cernuous, 0.5 to 0.7 mm. diam., dark red-brown, rarely purple; sporangium-wall forming a net with nearly square meshes, composed of numerous (40 to 50) rigid longitudinal ribs 5  $\mu$  thick, connected by slender transverse threads, and often forming an irregular net at the apex; basal cup scarcely developed. Stalk subulate, bent or twisted at the slender apex, rich purple-brown, one to three times the height of the sporangium. Spores pale red, minutely warted, 4 to 7  $\mu$  diam., usually with two to four purple plasmodic granules on the spore wall.—*Mucor cancellatus* Batsch Elench. Fung., ii. 135, fig. 232 a, b, c (1789). *Stemonitis cancellata* Gmel. Syst. Nat., 1468 (1791). *Cribraria cernua* Pers. Obs. Myc., i. 91 (1796). *C. exilis* Macbr. in Bull. Nat. Hist. Iowa, ii. 378 (1893). *Dictydium umbilicatum* Schrad. Nov. Gen. Pl., 11 (1797); Lister Mycetozoa, 148. *D. ambiguum* Schrad. l.c. ? *D. cernuum* Nees Syst. Pilze, 120, fig. 117 (1816); Rost. Mon., p. 229; Mass. Mon., 67. *D. trichiodes* Chev. Fl. Paris, i. 327 (1826). *D. longipes* Morgan Myx. Miami Valley, 17 (1893).

Var. 1.—**fuscum** Lister in Journ. Bot., xxxvi. 120 (1898): sporangia cernuous, smaller and browner than in the type, with a well-defined cup from the margin of which the numerous ribs arise.

Var. 2.—**alpinum** Lister: sporangia usually erect, brown, with or without an irregular cup; ribs from twenty to thirty, branching in the upper third of the sporangium to form an irregular *Cribraria*-like net; stalk not narrowed at the apex, often rugged.—*Dictydium anomalum* Meylan in Bull. Soc. Vaud., xlv. 295. *Heterodictyon mirabile* Rost. Mon., p. 231 (1875). *Cribraria mirabilis* Mass. Mon., 60 (1892).

Pl. 147.—a. to d. sporangia of various forms after the dispersion of the spores; a. typical form; b. var. *fuscum*; c. form with irregular net found with sporangia of usual type (England); d. erect sporangium (United States); e. spores, three of them show plasmodic granules adhering; f. g. sporangia of var. *alpinum* (type of *Heterodictyon mirabile* Rost., from Freiburg); h. spores of same with plasmodic granules adhering.

The ribs of the sporangium-wall are usually inflexed at the summit in maturity, and break the ball of enclosed spores by vertical pressure; they consist of two layers, the outer smooth and shining, the inner studded with purple plasmodic granules 1  $\mu$  diam.; in the typical form they are usually free at the base of the sporangium, but are sometimes connected by a small basal disc. In large developments of this species

at Lyme Regis, amongst typical sporangia irregular forms often occur with the ribs branching and anastomosing from the base or dividing in the upper half into a *Cribraria*-like network (see Pl. 147 c.); such irregular forms constitute the var. *anomalum* of Dr. Jahn.\* The var. *fuscum*, with its well-defined cup, is a widely distributed form, but is too inconstant to be regarded as a distinct species. The var. *alpinum* has been obtained usually at higher altitudes; Dr. Sturgis has gathered it on Cheyenne Mountain, Colorado, and M. Meylan finds it abundant in the Jura Mountains, at an elevation of 1,000 to 1,450 m. in the autumn months; the typical form he obtains earlier in the year, from June to August, below 1,300 in alt. The type of *Heterodictyon mirabile* Rost., from the Höllesteig gorge in the Black Forest, is this variety; the sporangia show irregular basal cups, and the ribs are in many parts expanded and form a loose imperfect net with broad and angular nodes; in other parts the ribs are connected by the usual delicate transverse threads, and, though fewer in number and coarser than in the type, are essentially of the same character. The specimen named *Cribraria exilis* by Prof. Macbride, from Nicaragua (B.M. 1026), is a slender purplish-red form of the present species, with a shallow cup connecting the parallel ribs at the base.

*Hab.* On dead wood. Common.—Lyme Regis, Dorset (B.M. 1438); Wanstead, Essex (B.M. 1439); Luton, Beds (B.M. 2769); Glamis, Scotland (B.M. 241); France (Paris Herb.); Sweden (B.M. 2771); Germany (B.M. 660); Austria (B.M. 1828); Switzerland (B.M. 2770); Italy (B.M. 659); Ceylon (B.M. 670); Christmas Island, Java (B.M. 1440); Borneo (B.M. slide); New Zealand (B.M. 2772); Japan (B.M. 2773); Iowa (B.M. 821); Philadelphia (B.M. 1858); Antigua (B.M. 1680); Brazil (B.M. 2774); var. *fuscum*—Hants (B.M. 2775); Aberdeen (B.M. 2777); Norway (B.M. 2776); Berlin (B.M. 2778); Switzerland (B.M. 2779); Japan (B.M. 2780); Montreal (B.M. 2781); var. *alpinum*—Jura Mountains (B.M. 2782); Colorado (B.M. 2783).

## Order II.—LICEACEAE.

Sporangia solitary, sessile or stalked; sporangium-wall cartilaginous, rarely membranous; capillitium and columella wanting.

### KEY TO THE GENERA OF LICEACEAE.

Sporangia sessile, subglobose or forming plasmodiocarps.

(29) LICEA.

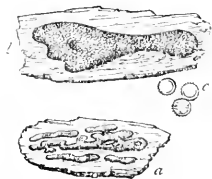


Fig. 37.

Fig. 37.—*Licea flexuosa* Pers.

- a. Group of plasmodiocarps. Twice natural size.
- b. Plasmodiocarp. Magnified 6 times.
- c. Spores. Magnified 200 times.

\* A full account of the development of this species and some of the varieties to which it is subject, is given by Dr. Jahn. in Ber. Deutsch. Bot. Ges., xix., pp. 97-115 (1901).

Sporangia stalked, furnished with a lid of thinner substance.

(30) ORCADELLA.

Fig. 38.—*Orcadella operculata* Wingate.

a. Group of sporangia. Magnified 8 times.

b. Sporangium with open lid. Magnified 80 times.

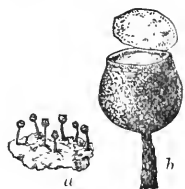


Fig. 38.

Genus 29.—**LICEA** Schrader Nov. Gen. Pl., 16 (1797). Sporangia sessile, subglobose, hemispherical, or forming plasmodiocarps; sporangium-wall cartilaginous (membranous in *L. biforis*); spores olive-brown, lilac-brown or nearly colourless.

KEY TO SPECIES OF *LICEA*.

A. Sporangium-wall cartilaginous :—

Sporangia hemispherical, dehiscing in lobes; spores brown, 9 to 11  $\mu$ . 1. *L. minima*

Sporangia subglobose or bolster-shaped, dehiscing in lobes; spores almost colourless, 8 to 10  $\mu$ . 2. *L. castanea*

Sporangia pulvinate, dehiscing in lobes; spores 16 to 20  $\mu$ . 3. *L. pusilla*

Plasmodiocarps elongate, 2 to 4 mm. long, dehiscing irregularly. 4. *L. flexuosa*

B. Sporangium-wall membranous; plasmodiocarps about 0.2 mm. long, 0.1 mm. wide, dehiscing by a longitudinal fissure. 5. *L. biforis*

1. ***L. minima*** Fr. Syst. Myc., iii. 199 (1829). Plasmodium yellow (*teste* Rex). Sporangia scattered, hemispherical on a broad base, depressed, 0.2 to 0.5 mm. diam., brown or nearly black, dehiscing in three or four lobes; sporangium-wall cartilaginous, dark brown, opaque with granular deposits, except the margins of the lobes which are dotted on the inner side with plasmodic granules 1 to 2  $\mu$  diam. Spores olivaceous-brown or lilac-brown, spinulose, 9 to 12  $\mu$  diam., the wall thinner on one side.—Macbr. N. Am. Slime-Moulds, 148; Torrend Fl. Myx., 66. *Tubulina minima* Mass. Mon., 36. *Kleistobolus pusillus* Lippert in Verh. Zool.-Bot. Gesell. Wien. xliv. 70, t. iii (1894).

Pl. 148.—d. sporangia (United States); e. spores and fragment of sporangium-wall showing the plasmodic granules on the margin of a lobe; f. spore.

This minute species is closely allied to *L. pusilla* from which it differs in the entire lobes of the sporangium and the smaller rougher spores. Glycerine preparations of the type of *Kleistobolus pusillus*

Lippert, kindly lent by Prof. v. Höhnelt, show this to be a nearly typical example of the present species. The rudimentary capillitium described by Lippert consists apparently of fungus hyphae traversing the substratum on which the sporangia are seated. The spores are faintly warted and measure 11 to 13  $\mu$ , not 7 to 9  $\mu$ , as stated by Lippert.

*Hab.* On dead coniferous wood.—Finland (B.M. 654); Sweden (K. 1646); Norway (B.M. slide); Germany (B.M. 2784); Austria (B.M. 2786); Bohemia (Herb. Celakovsky); Portugal (B.M. 2785); New Jersey (B.M. slide); Adirondack Mountains, New York (B.M. slide).

2. *L. castanea* G. Lister in Journ. Bot., xlix. 61 (1911). Plasmodium? Sporangia scattered, sessile, subglobose, or forming bolster-shaped plasmodiocarps, 0.2 to 0.9 mm. long, 0.2 to 0.4 mm. broad, chestnut or pale brown, smooth or wrinkled; sporangium-wall somewhat cartilaginous, nearly colourless or pale brown, overlaid by a more or less continuous layer of brown granular refuse matter, dehiscing along definite lines to form plates or lobes whose margins are often marked with a row of plasmodic granules 1  $\mu$  diam. Spores in mass olive-yellow, when magnified almost colourless, smooth, 8 to 10  $\mu$  diam., their walls rather thinner on one side.

This inconspicuous species was discovered in November, 1910, by the Rev. W. Cran at Lesmoir, Aberdeenshire, on moss and the bark of *Pyrus Aucuparia*. In size it resembles *L. minima*, but it is distinguished by the paler sporangia, usually areolated with prominent lines of dehiscence, and by the smooth, pale spores.

*Hab.* On moss and bark.—Lesmoir, Aberdeenshire (B.M. 3201).

3. *L. pusilla* Schrad. Nov. Gen. Pl., 19 (1797). Plasmodium? Sporangia scattered, hemispherical or pulvinate, 0.6 to 1 mm. diam., dark purple-brown, glossy on the inner side, dehiscing in irregular lobes; sporangium-wall cartilaginous, chestnut-brown, the margins of the lobes usually crenate and undulate, dotted with plasmodic granules 1 to 2  $\mu$  diam. Spores olive-brown, 16 to 20  $\mu$  diam., closely and minutely warted, the wall thinner on one side.—Macbr. N. Am. Slime-Moulds, 148. *Protoderma pusilla* Rost. Mon., p. 90 (1875). *Protodermium pusillum* Berl. in Sacc. Syll., vii. 328 (1888); Mass. Mon., 43.

Pl. 149.—a. sporangia; b. fragment of sporangium-wall, and spores; c. spore (Scotland).

This species was separated by Rostafinski from *Licea*, and placed in the division *Amaurosporeae* as the type of a separate genus *Protoderma*, on account of the colour of the spores. The examination of several specimens in Strassb. Herb. and British Museum shows that the colour of the spores is essentially olive-brown; Schrader's original place for the species is therefore retained.

*Hab.* On dead wood.—Glamis, Scotland (B.M. 100); Sweden (B.M. 2787); Poland (Strassb. Herb.); near Kiel, Germany (B.M. 2788).

4. *L. flexuosa* Pers. Syn. Fung., 197 (1801). Plasmodium dull yellow or rose-coloured. Sporangia scattered, pulvinate, depressed, or forming straight curved or branching plasmodiocarps 1 to 6 mm. long, either yellowish-brown and glossy, or dark brown and opaque when an outer layer of refuse matter is present; sporangium-wall cartilaginous, translucent, pale purplish-brown, usually more or less overlaid with a thick mottled layer of olive-brown refuse matter, dehiscing irregularly. Spores pale olive-brown, spinulose, 11 to 14  $\mu$  diam., yellowish-brown in mass.—Fr. Syst. Myc., iii. 197; Rost. Mon., p. 218. *L. variabilis* Schrad. Nov. Gen. Pl., 18, pl. 6, figs. 5, 6 (1797)?; Macbr. N. Am. Slime-Moulds, 146. *L. Serpula* Fr. Symb. Gast., 12 (1817)? *L. alutacea* Wallr. Fl. Crypt. Germ., 344 (1833). *L. Schoenleinii* Johow Estud. Fl. Juan Fernandez, 195 (1896)? *Tubulina flexuosa* Poiret in Lam. Ency. Meth., viii. 131 (1808); Mass. Mon., 37.

Pl. 148.—*a.* plasmodiocarp (England); *b.* fragment of sporangium-wall and spores; *c.* spore.

In the field this species somewhat resembles *Enteridium olivaceum* var. *liceoides*, and also *Dianema corticatum*; it differs from both in the rough granular deposits on the sporangium-wall and in the yellowish-brown colour of the spores.

*Hab.* On dead coniferous wood.—Witley, Surrey (B.M. 2789); Alderbury, Wilts (B.M. 2790); Savernake Forest, Wilts (B.M. 2791); Yorks (B.M. 2792); Northumberland (B.M. 2794); Aberdeen (B.M. 2795); Ireland (B.M. 2793); Norway (B.M. 1441); Freiburg, Germany (Strassb. Herb.); Holstein (B.M. 2796).

5. *L. biforis* Morgan Myx. Miami Valley, 5, fig. 1 (1893). Plasmodium? Sporangia scattered, forming minute ellipsoid or fusiform plasmodiocarps, 0.2 mm. long, 0.1 mm. broad, glossy, yellow-brown, dehiscing along a central ridge or depression; sporangium-wall membranous, minutely papillose, almost colourless, with scanty superficial deposits of discharged refuse matter. Spores somewhat ovoid, the wall thinner on one side, 12 by 9  $\mu$ , almost colourless and smooth, pale ochraceous in mass.—Macbr. N. Am. Slime-Moulds, 147; Lister in Journ. Bot., xlii. 135.

Pl. 149.—*g.* six sporangia (Philadelphia); *h.* three sporangia; *i.* fragment of sporangium-wall and spores; *k.* spore.

This species is almost too small to be detected with the naked eye; when magnified one hundred times it bears considerable resemblance to a date stone.

*Hab.* On dead wood.—Philadelphia (B.M. 2061).

The descriptions of *Licea badia* Fr. and *L. incarnata* Preuss are too brief to be instructive; the species should therefore be discarded.

Genus 30.—**ORCADELLA** Wingate in Proc. Acad. Nat. Sci. Phil., 1889, 280. Sporangia stalked; sporangium-wall opaque with granular deposits except in the upper part where it forms a membranous lid.

123. *O. operculata* Wing. l.c. Plasmodium? Total height 0.4 to 0.9 mm. Sporangia scattered, urn-shaped or subglobose, stalked, erect, 0.1 to 0.3 mm. diam., brown or nearly black, provided with a convex or dome-shaped dull yellow glossy lid; sporangium-wall cartilaginous, opaque from deposits of refuse matter; lid membranous, minutely papillose. Stalk cylindrical or subulate, furrowed, nearly black, filled with dark refuse matter. Spores almost colourless and smooth, 8 to 11  $\mu$  diam., yellowish or pink in mass.—Mass. Mon., 49; Macbr. N. Am. Slime-Moulds, 158.

Pl. 149.—*d.* sporangia; *e.* fragment of sporangium-wall and papillose lid, with spores; *f.* spore; (United States).

This minute species was first found by Mr. Harold Wingate in Fairmount Park, Philadelphia, where it appeared in some abundance on oak bark. In December, 1908, a remarkable variety of *O. operculata* was obtained in England by Mr. W. H. Burrell. The sporangia were found on Hepaticae growing on beech bark, at Stratton Strawless, Norfolk; they differ from the type in having an ill-defined lid and in the walls being dark and cartilaginous at the base only; the remaining sporangium-walls are membranous, pale olive-brown, translucent and minutely papillose, and have a somewhat faceted appearance from being marked with superficial patches of refuse matter; the spore walls are colourless, but the contents are pale rose-coloured; this rosy tint gives a striking appearance to the emerging swarm cells (see Burrell in Trans. Norf. & Norw. Nat. Soc., ix, 106). Mr. Cran finds a similar form near Aberdeen, associated with sporangia having well-defined lids.

*Hab.* On dead bark.—Norfolk (B.M. slide); near Aberdeen (B.M. 3202); N. Germany (Herb. Dr. Rönn); Philadelphia (B.M. 1899).

### Order III.—TUBULINACEAE.

Sporangia clustered, cylindrical or ellipsoid, stalked or sessile; sporangium-wall membranous, pale rufous, without plasmodic granules; spores minutely reticulated, 4 to 7  $\mu$  diam.

#### KEY TO THE GENERA OF TUBULINACEAE.

Sporangia cylindrical, compacted, with or without pseudo-columella. (31) TUBIFERA.



Fig. 39.

Fig. 39.—*Tubifera ferruginosa* Gmel.

Cluster of sporangia. Magnified  $2\frac{1}{2}$  times.



Sporangia clustered, stalked, ellipsoid; capillitium a brush of tubular threads attached above and below to the sporangium-wall.

(32) *ALWISIA*.

Fig. 40.—*Alwisia Bombarda* Berk. & Br.

- a. Three clusters of sporangia. Twice natural size.
- b. Immature sporangium; the capillitium is seen through the transparent walls. (Drawn from a glycerine mounting.) Magnified 12 times.
- c. Upper portion of three capillitium threads, showing attachment to the sporangium-wall. Magnified 70 times.

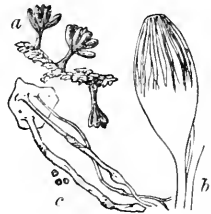


Fig. 40.

Genus 31.—**TUBIFERA** Gmelin Syst. Nat., ii. 1472 (1791). Sporangia cylindrical, crowded on a common hypothallus.

#### KEY TO THE SPECIES OF *TUBIFERA*.

##### A. Sporangia without pseudo-columella:—

Sporangia clustered on a broad hypothallus, spores 5 to 8  $\mu$ .

1. *T. ferruginosa*

Sporangia clustered on a stalk-like hypothallus, spores 3 to 5  $\mu$ .

2. *T. stipitata*

##### B. Sporangium-wall with tubular extensions connecting it with a hollow pseudo-columella.

3. *T. Casparyi*

1. *T. ferruginosa* Gmel. l.c. Plasmodium watery-white, rarely bright yellow, changing to either rose-red or mulberry-red in the young sporangia. Sporangia densely crowded, cylindrical, angled by mutual pressure, convex or conical above, 3 mm. long, 0.4 mm. broad, light reddish-brown or umber, seated on a common spongy hypothallus and forming a honeycomb-like rufous-brown mass, 2 to 7 cm. in breadth; sporangium-wall membranous, pale rufous-brown. Spores pale rufous-brown, closely and minutely reticulated over the greater part of the surface, the remaining part nearly smooth, or marked with broken ridges, 5 to 8  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 156. *Stemonitis ferruginosa* Batsch Elench. Fung., 261, fig. 175 (1786). *Tubulifera ceratum* Müll. Fl. Dan., t. 659, fig. 2 (1777) ? (nomen). *T. arachnoidea* Jacq. Misc., i. 144, t. 15 (1778) ? *T. coccinea* Trentep. in Roth Catal. Bot., i. 243 (1797). *Sphaerocarpus cylindricus* Bull. Champ., 140, t. 470, fig. 3 (1791). *S. fragiformis* Bull. l.c., 141, t. 384. *Tubulina fragiformis* Pers. in Roemer N. Mag. Bot., i. 91 (1794); Lister Mycetozoa, 153. *T. fallax* Pers. Obs. Myc., ii. 28 (1799). *T. cylindrica* DC. Fl. Fr., ii. 249 (1805); Rost. Mon., p. 220; Rex in Bot. Gaz., xv. 315; Mass. Mon., 39. *T. conglobata* Preuss in Linnaea, xxiv. 140 (1851). *T.*

*nitidissima* Berk. in Journ. Linn. Soc., xviii. 387 (1881). *T. speciosa* Speg. in Atti Soc. Critt. Ital., ser. 2., iii. 62 (1881). *Licea fragiformis* Nees Syst., 107 (1816). *L. cylindrica* Fr. Syst. Myc., iii. 195 (1829). *L. iricolor* Zoll. in Flora, xxx. 300 (1847). *L. rubiformis* Berk. & Curt. in Proc. Am. Acad. Arts. & Sci., iv. 125 (1860). *L. microsperma* Berk. & Curt. in Grev., ii. 68 (1873).

Pl. 150.—*a.* tubular sporangia clustered on a spongy barren base; *b.* spores; in two the side is shown on which the reticulation is imperfect (England); *c.* part of a cluster of sporangia with conical summits (United States).

The sporangium-wall when highly magnified is seen to be more or less beset with minute colourless granules; small pouches may also be occasionally observed extending inwards to a greater or less degree, which in some forms are produced into tubes passing across the sporangium or taking an oblique course; this appearance indicates a tendency in the direction of the marked development of tubular processes in *T. Casparyi*. The substance of the sporangium-wall varies in different gatherings; it may be iridescent and delicately membranous, or firm and of considerable thickness. As the young thin-walled sporangia mature their colour changes from rose-red to chestnut-brown; in stouter forms the young sporangia change from dark mulberry-red to dark brown (see Rex l.c., 318). There is also some variation in the shape of the upper portion of the sporangium; in some specimens of the more fragile type the apex is produced into a sharp cone; in others the sporangia are cylindrical, obtuse, and but slightly connected with each other, those on the outside of the cluster being often entirely free; in the stouter type the walls are closely compacted, and their apices form a level tessellated surface.

*Hab.* On dead wood. Common.—Bowood, Wilts (B.M. 302); Pulloxhill, Beds (B.M. 2797); Clifton, Nottinghamshire (B.M. 1103); Penzance (B.M. 303); Wales (B.M. 9); Aberdeen (B.M. 2798); France (Paris Herb.); Germany (B.M. 656); Norway (B.M. 1443); Finland (B.M. 655); Poland (Strassb. Herb.); Switzerland (B.M. 2799); Austria (B.M. 1886); India (K. 1650); Ceylon (Peradeniya Herb.); Java (B.M. 1104); Australia (K. 1653); New Zealand (B.M. 2800); Japan (B.M. 2015); Muskoka, Canada (B.M. 2801); Philadelphia (B.M. 1443A); Iowa (B.M. 823); South Carolina (K. 806).

**2. *T. stipitata*** Macbr. N. Am. Slime-Moulds, 157 (1899). Plasmodium white or colourless (*teste* Rex). Sporangia in shape, size, and colour as in *T. ferruginosa*, usually clustered on a dark brown spongy hypothallus, which has the form of a stout stalk 2 to 3 mm. high. Spores pale rufous-brown, minutely reticulated over the greater part of the surface, the remaining part smooth or marked with ridges, 3 to 5  $\mu$  diam.—*Licea stipitata* Berk. & Rav. ex Berk. & Curt. in Proc. Amer. Acad. Arts. & Sci., iv. 125 (1860). *Tubulina stipitata* Rost. Mon., p. 223 (1875); Rex in Bot. Gaz., xv. 318; Mass. Mon., 38; Lister Mycetozoa, 154.

Pl. 150.—*d.* cluster of sporangia on a stalk-like base; *e.* spores, one shows the side on which the reticulation is imperfect; (United States).

Dr. Rex considers this a distinct species from *T. ferruginosa*, specially marked by the smaller spores. The stalk is a less important character,

for he states that sessile clusters are not uncommon. The conical form supplied by him and referred to under *T. ferruginosa* has spores measuring 4 to 6  $\mu$ , and represents an intermediate form. Mr. Petch, describes a Ceylon gathering in which the sporangia occur singly or in groups of three to twelve or more; in some clusters the outer sporangia are reflexed as in *Alwisia bombardia* (see Petch in Ann. Perad., iv. 357).

*Hab.* On dead wood.—Ceylon (B.M. 2802); Java (B.M. 2803); Japan (B.M. 2016); Bonin Islands (K. 821); South Carolina (B.M. 538); Cuba (B.M. 539); Antigua (B.M. 1681); St. Vincent Island (B.M. 1556); Philadelphia (B.M. 2804).

3. **T. Casparyi** Macbr. N. Am. Slime-Moulds, 157 (1899). Plasmodium white. Sporangia closely compacted, resembling *T. ferruginosa* in shape, size and colour; sporangium-walls connected with a long central columella by numerous straight tubular processes. Spores pale rufous-brown, closely reticulated over the greater part of the surface, loosely reticulated over the remaining part, 6 to 7  $\mu$  diam.—*Siphoptychium Casparyi* Rost. Mon., App. p. 32 (1876); Rex in Bot. Gaz., xv. 319; Mass. Mon., 89; Lister Mycetoza, 155.

Pl. 150.—*f.* portion of two sporangia with their walls partially broken away, showing the pseudo-columella and capillitium; *g.* portion of pseudo-columella and capillitium; *h.* spores, two show the side on which the reticulation is lax; (United States).

Dr. Rex is of opinion that the columella in this species may be viewed as an aborted sporangium; he writes, "Aethalia are found in which from one-third to one-half of the component sporangia lack both columellas and connecting threads" (l.c.).

*Hab.* On dead wood.—Sweden (B.M. 2805); Adirondack Mountains New York (B.M. 1882); Iowa (B.M. 1021); Washington State (B.M. 2806).

*Tabulina guaranitica* Mass. Mon., 39, from Guarapi, Argentine Republic, does not belong to the Mycetoza; it consists of stalked heads composed of a densely interwoven tissue of brown septate branching hyphae, bearing numerous umber spores, 2 to 7  $\mu$  diam., in the upper part; it belongs to the *Hyphomyces*.

*Tubulina spumarioidea* Mass. Mon., 42 (K. 801), syn. *Licea spumarioidea* Cooke & Mass. in Grev., xvi. 74, is also a hyphomycetous fungus, *Sepedonium chrysospermum* Link.

Genus 32.—**ALWISIA** Berkeley & Broome in Journ. Linn. Soc., xiv. 86 (1873). Sporangia clustered, stalked, ellipsoid; sporangium-wall falling away in the upper half and exposing a stiff brush of capillitium threads.

1. **A. Bombarda** Berk. & Br. l.c., 87. Plasmodium? Total height 4 mm. Sporangia in clusters of four to eight, stalked, cylindrical-ellipsoid, 1 to 1.5 mm. high, 0.5 mm. broad, rufous-brown, the outer sporangia of a cluster usually reflexed; sporangium-wall membranous, evanescent above,

persistent below, pale red, beset with minute scattered granules on the inner side, and occasionally produced into small pouches. Stalks cylindrical, 2.5 mm. high, 0.15 mm. thick, adhering in clusters of 4 to 12, brownish-purple; when mounted in glycerine, orange-red. Capillitium consisting of slender straight and nearly simple tubular threads 0.5 to 0.8 mm. long, 3 to 8  $\mu$  wide, attached above by slender points to the fugaceous apical sporangium-wall, and also below to the interior of the cup-like base of the sporangium, where they often branch and anastomose; they may be interrupted by bulbous swellings 20 to 40  $\mu$  long, and are either smooth or closely studded with slender spines 2 to 3  $\mu$  in length. Spores pale reddish-brown, reticulated over two-thirds their surface, 5 to 6  $\mu$  diam.—Lister in Journ. Bot., xlii. 135; Fischer in Mitth. Naturf. Ges. Bern., 1906, 121, figs. 11-14 (1907). *Trichia fragilis* Rost. Mon. App., p. 39, in part. *Prototrichia Bombarda* Mass. Mon., 128 (1892).

Pl. 151.—*a.* three clusters of sporangia (Ceylon); *b.* cluster of sporangia, the upper walls have broken away exposing the capillitium threads (Jamaica); *c.* group of capillitium threads attached above and below to the sporangium-walls; *d.* upper ends of three threads of capillitium, and spores; *e.* lower ends of capillitium threads showing attachment to the sporangium-wall; *f.* part of capillitium-thread and spores.

On maturity the cup of the sporangium splits into reflexed lobes bearing the persistent threads of the capillitium in the form of a diffuse tuft. The type of this remarkable species is an immature gathering made by Thwaites in Ceylon in 1868; since then it has been obtained again in that island by Mr. Petch in a mature state (see Petch in Ann. Perad., iv. 357); it has also been found in Sumatra, and in the Blue Mountains, Jamaica. Although differing from the other species of the *Tubulinaceae* in the mode of dehiscence and in the capillitium, it agrees with them completely in the colour and structure of the sporangium-wall and in the character of the spores.

*Hab.* On dead wood.—Gongolla Forest, Ceylon (B.M. 1000); Jamaica (B.M. 2807).

#### Order IV.—RETICULARIACEAE.

Sporangia closely compacted and usually forming an aethalium; sporangium-walls without plasmodic granules, usually incomplete, perforated, or forming a spurious capillitium; true capillitium none, or in *Liceopsis* consisting of a few branching threads and strands.

#### KEY TO THE GENERA OF RETICULARIACEAE.

##### A. Sporangia forming aethalia\* :—

Sporangia columnar; sporangium-walls incomplete, dome-shaped at the apex, continued down to the base in four to six straight threads.

##### (33) DICTYDIAETHALIUM.

\*Sporangia forming elongated or net-like plasmodiocarps in *Enteridium olivaceum* v. *livoides*.

Fig. 41.—*Dictydiaethalium plumbeum* Rost.

- a. Aethalium. Natural size.  
 b. Eight sporangia of an aethalium isolated; in three the column of spores has fallen away, leaving the cap and persistent threads. Magnified 20 times.

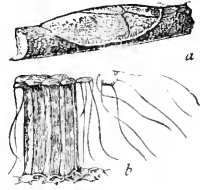


Fig. 41.

Walls of convoluted sporangia perforated and forming a uniform tissue of interarching bands.

## (34) ENTERIDIUM.

Fig. 42.—*Enteridium olivaceum* Ehrenb.

- a. Plasmodiocarp. Magnified twice.  
 b. Part of spurious capillitium. Magnified 35 times.  
 c. A spore cluster, and one isolated spore. Magnified 210 times.

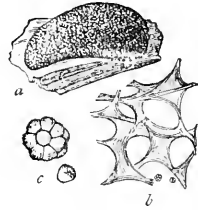


Fig. 42.

Walls of convoluted sporangia incomplete, forming strands and folds with numerous anastomosing threads.

## (35) RETICULARIA.

Fig. 43.—*Reticularia Lycoperdon* Bull.

- a. Aethalium. Natural size.  
 b. Fragment of capillitium. Magnified 100 times.

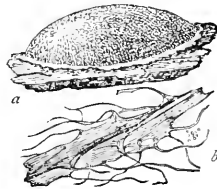


Fig. 43.

B. Sporangia subglobose, closely compacted; inner walls usually complete.

## (36) LICEOPSIS.

Fig. 44. *Liceopsis lobata* Torrend.

- a. Two groups of sporangia. Magnified 5 times.  
 b. Capillitium. Magnified 50 times.  
 c. Spore. Magnified 450 times.



Fig. 44.

Genus 32.—**DICTYDIAETHALIUM** Rostafinski Versuch, 5 (1873). Aethalium pulvinate, formed of erect columnar sporangia; sporangium-walls incomplete, dome-shaped at the apex, continued down to the basal membrane in four to six straight threads; capillitium none. *CLATHROPTYCHIUM* Rost. Mon., p. 225 (1875).

1. **D. plumbeum** Rost. Versuch, 5 (1873). Plasmodium rose-red. Aethalium 1 to 3 cm. broad, 0.5 to 1 mm. thick, dull slate-coloured or clay-coloured, iridescent, arcolated with the convex apices of the sporangia; sporangia cylindrical, angled by mutual pressure, 0.5 to 1 mm. high, 0.2 mm. broad; sporangium-wall persistent and dome-shaped at the apex, subcartilaginous, continued down to the basal membrane in four to six straight threads 2 to 4  $\mu$  thick and triangular in section, evanescent between the threads. Spores clay-coloured or yellow in mass, when magnified pale yellow, spinulose, 9 to 12  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 152. *Fuligo plumbea* Schum. Enum. Pl. Saell., ii. 193 (1803). *Reticularia plumbea* Fr. Syst. Myc., iii. 88. *R. entoxantha* Berk. in Hook. Journ. Bot., iii. 201 (1851). *R. lurida* Berk. & Br. in Journ. Linn. Soc., xiv. 82 (1873). *Licea rugulosa* Wallr. Fl. Crypt. Germ., ii. 345 (1833). *L. appianata* Berk. in Hook. Lond. Journ. Bot., iv. 67 (1845). *L. cinnabarina* Berk. & Br. l.c., 86 (1873). *L. tenuissima* Berk. & Br. l.c. *Dictydiaethalium appianatum* Rost. in Fuckel Symb. Myc., Nachtr., ii. 69 (1873). *D. dissiliens* Hazsl. in Oester. Bot. Zeitsch., xxvii. 85 (1877). *Clathroptychium rugulosum* Rost. Mon., p. 225 (1875); Mass. Mon., 51. *C. cinnabarinum* Sacc. in Michelia, i. 545 (1879). *C. Berkeleyi* Mass. l.c., 53 (1892).

Pl. 152.—*a.* part of an aethalium seen from above; *b.* tubular sporangia from an aethalium; in two of them the spores are dispersed and the caps and threads of the sporangium-walls are left free; *c.* sporangia from a stouter aethalium; *d.* cap and threads of sporangium-wall; *e.* floor of aethalium arcolated with the bases of the sporangia; *f.* spores and portion of a thread; *g.* spores and portion of thread from aethalium drawn at *c.* (England); *h.* spore and thread from a stout aethalium (Sikkim, K. 1669); *i.* spore (England); *k.* spore from type of *Clathroptychium Berkeleyi* Mass.

The spores are dispersed by the threads giving way at the base and the sporangia separating in tufts from the persistent shining base of the aethalium. American specimens have been received from Dr. Rex showing an abnormal development; the sporangium-walls are, to a great extent, continuous between the threads, and form a lattice work with wide expansions. An unusually stout form from Sikkim (K. 1669) was named *Reticularia entoxantha* by Berkeley, but is referred by Rostafinski to the present species; it is an olive-black aethalium, 3 mm. thick, and bright yellow within; the threads of the sporangia are 10  $\mu$  diam., waved and thickened at the margins; the spores are yellow and spinulose, 9 to 11  $\mu$ ; similar aethalia have been obtained by Prof. Thaxter from Corral, Chili. *Clathroptychium Berkeleyi* Mass., from Ceylon (K. 1666), differs only from the robust forms of *D. plumbeum* in the more strongly spinulose spores; but

as the spores of most gatherings vary in the amount of roughness, this character alone is not sufficient to mark specific difference. *Clathroptychium cinnabarinum* Sacc. from N. Italy, is described as having vermilion sporangia with blackish-purple opercula and threads; this description applies to immature specimens of *D. plumbeum*.

*Hab.* On dead wood; not unfrequent.—Rudloe, Wilts (B.M. 20); Batheaston, Somerset (B.M. 292); Luton, Beds (B.M. slide); Yorks (B.M. 2808); Aberdeenshire (B.M. 2809); France (Paris Herb.); Germany (Strassb. Herb.); Hungary (K. 828); Portugal (B.M. 2810); Ceylon (K. 1664); Sikkim (K. 1669); Australia (K. 834); Philadelphia (B.M. 3196); New Jersey (B.M. 945); South Carolina (B.M. 928); West Indies (B.M. 2811).

Genus 34.—**ENTERIDIUM** Ehrenberg in Spreng. Jahrb. Gewächsh., i. pt. 2, 55 (1818). Aethalium composed of confluent interwoven sporangia, their walls perforated with large openings (sporangia more or less free, forming plasmodiocarps in *E. olivaceum* var. *liceoides*); capillitium none.

#### KEY TO THE SPECIES OF *ENTERIDIUM*.

Spores warted, usually clustered. 1. *E. olivaceum*  
Spores reticulated, free. 2. *E. Rozeanum*

1. *E. olivaceum* Ehrenb. l.c., 57. Plasmodium rose-red. Aethalium pulvinate, depressed, 1 mm. to 3 cm. broad, 1 to 3 mm. thick, smooth or rugulose, dark olive-brown, often glossy; sporangium-walls yellow-olive, subcartilaginous, perforated with wide openings forming a network with broad winged boundaries to the meshes. Spores in clusters of 6 to 20, sometimes free, pale olive, thickened and warted on one side, 9 to 12  $\mu$  diam.—Rost. Mon., p. 227; Mass. Mon., 44. *Lycoperdon unguinum* Schum. Enum. Pl. Saell., ii. 192 (1803)? *Reticularia versicolor* Fr. Syst. Orb. Veg., i. 147 (1825). *R. olivacea* Fr. Syst. Myc., iii. 89 (1829). *R. unguina* Fr. l.c.? *R. applanata* Berk. & Br. in Ann. Mag. Nat. Hist., ser. 3. xviii. 56, t. ii., fig. 3 (1866). *Licea olivacea* Fuckel Symb. Myc., 338 (1869). *Licaethalium olivaceum* Rost. Versuch, 4 (1873). *Enteridium atrum* Preuss in Linnaea, xxiv. 142 (1851). *E. simulans* Rost. Mon., App. p. 30. *E. antarcticum* Speg. in Bol. Acad. Nac. Cienc. Cord., xi. 363 (1887)? *E. Rostrupii* Raunk. in Bot. Tidssk., xvii. 106 (1890). *E. macrosperma* Raunk. l.c.

Var. *liceoides* Lister: sporangia forming long, often branched and net-like plasmodiocarps.—Journ. Bot., xxxiv. 211 (1896).

Pl. 153.—*a.* aethalium (England); *b.* perforated sporangium-walls and spore clusters; *c.* cluster of spores; *d.* plasmodiocarps of var. *liceoides*.

The var. *liceoides* is connected with the type by such gatherings as that named by Prof. Raunkiaer *E. Rostrupii* (B.M. 1722), in which the aethalium consists of only two or three layers of sporangia. A specimen

(B.M. 2813) obtained by Mr. W. B. Allen in the rosy plasmodium stage at Shirlett, Salop, and matured indoors, shows all stages between single spherical sporangia, 0.2 to 0.3 mm. diam., small subglobose aethalia 1 to 2 mm. diam., and larger aethalia 5 to 10 mm. long; the spores are perfectly formed and free. This variety of form from one plasmodium is probably due to unfavourable conditions of development.

*Hab.* On dead wood.—Ascot, Berks (B.M. 14); Kent (B.M. 13); Boynton, Yorks (B.M. 1158); Shirlett, Salop (B.M. 2813); Norfolk (B.M. 2814); Appin, Scotland (K. 1670); France (B.M. 2816); North Germany (B.M. 2815); Denmark (B.M. 1722); Poland (Strassb. Herb.); Bohemia (B.M. 2817); New Jersey (K. 835): var. *liceoides*—Alderbury, Wilts (B.M. 1712); North Germany (B.M. 2232); New Hampshire (B.M. slide).

2. *E. Rozeanum* Wing. in Proc. Acad. Nat. Sci. Phil., 1889, 156. Plasmodium flesh-coloured. Aethalium hemispherical or subglobose, 5 to 30 mm. diam., red-brown; sporangium-walls within the aethalium perforated, forming a network of broad membranous bands, or sometimes frayed into strands and slender threads as in *Reticularia*. Spores rusty-brown, closely and evenly reticulated on two-thirds of the surface, the remaining part faintly warted, 7 to 9  $\mu$  diam.—Macbr. in Bull. Nat. Hist. Iowa, ii. 117; Mass. Mon., 46. *Reticularia* (?) *Rozeana* Rost. Mon., App. p. 33 (1876). *R. splendens* Morg. Myx. Miami Valley, 11 (1893). *Enteridium splendens* Morg. in litt.; Macbr. N. Am. Slime-Moulds, 151 (1899).

Pl. 153.—*e.* aethalium; half is seen in vertical section, showing the persistent sporangium-walls and the barren base; *f.* perforated sporangium-walls; *g.* spores; (United States).

Mr. Wingate states that specimens received by him from M. Roze, obtained from near Paris, identify the American gatherings with *Reticularia Rozeana* Rost., the type of which appears to be now lost. No further European gatherings of the present species appear to have been obtained. Prof. Macbride is of the opinion that Wingate's identification may have been incorrect, and prefers to use a later name, given by Morgan, *E. splendens*, for what is a common American species. There is no doubt, however, that the specimens from Philadelphia described by Wingate as *E. Rozeanum* are the present species, and we do not seem to have sufficient evidence to disturb the name he adopted.

*Hab.* On dead wood.—British Columbia (B.M. 2819); Maine (B.M. 1613); Ohio (B.M. 1446); Iowa (B.M. 1445); Colorado (B.M. 2820).

Genus 35.—**RETICULARIA** Bulliard Champ., 95 (1791). Aethalium composed of numerous elongated interwoven sporangia, whose walls are partly evanescent, partly persistent, and form broad expansions and strands dividing above into delicate capillitium-like threads; spores and threads rusty-brown.



1. *R. Lycoperdon* Bull. l.c., t. 446, f. 4 (1791). Plasmodium creamy-white. Aethalium pulvinate or subglobose, 5 mm. to 6 cm. diam., brownish copper-coloured or enclosed in a thin smooth silvery cortex, seated on a well-developed hypothallus of interwoven membranous strands. Capillitium consisting of the persistent remains of the sporangium-walls, forming irregular branching strands arising from the hypothallus, dividing above into numerous slender flattened and flexuose rusty-brown threads. Spores somewhat turbinate, rusty-brown, thickened and closely reticulated on the rounded side, the remaining part marked with scattered warts, 6 to 8  $\mu$  diam.—Rost. Mon., p. 240; Mass. Mon., 93; Macbr. N. Am. Slime-Moulds, 149. *R. argentea* Poiret in Lam. Encycl. Meth., vi. 183 (1804). *R. umbrina* Fr. Syst. Myc., iii. 87 (1829). *R. jurana* Meylan in Bull. Soc. Vaud., xlv. 297 (1908). *Lycogala argentea* Pers. in Roemer N. Mag. Bot., i. 87 (1794). *L. turbinata* Pers. Syn. Fung., 158 (1801). *Fuligo Lycoperdon* Schum. Enum. Pl. Saell., ii. 193 (1803).

Pl. 154.—a. aethalium; b. capillitium; c. spores (England).

When developed in a moist atmosphere under a glass shade, the barren silvery cortex formed by the drying of the outer ends of the sporangia is not produced, and the convolute sporangia are filled with spores to their apices, which gives an irregular brain-like surface to the aethalium. In some gatherings the walls of the sporangia are much more persistent than in others, and have almost the character of *Enteridium*, to which genus *Reticularia* is closely allied. M. Meylan has courteously sent us specimens of what he regards as a new species, *R. jurana*, (B.M. 2824), obtained from several stations in the Jura Mountains, at an elevation of from 1,300 to 1,500 m.; he gives as the distinguishing characters the small size of the aethalia, which measure 5 to 10 mm. diam., their fragile copper-coloured surface walls, and the faint reticulation of the spores. Similar aethalia are not unfrequent in the British Isles, and appear to be forms of *R. Lycoperdon* resulting from small plasmodia matured in sheltered situations.

*Hab.* On dead wood. Common in the British Isles.—Bristol (B.M. 18); Leytonstone, Essex (B.M. 1447); Luton, Beds (B.M. 2823); Cornwall (B.M. 2821); Ireland (B.M. 2822); Germany (B.M. 649); Sweden (K. 977); Portugal (B.M. 2825); Ceylon (B.M. 2826); Washington State (B.M. 2827); Massachusetts (B.M. 2826).

*Reticularia apiospora* Berk. & Br., *R. atrorufa*, Berk. & Curt., *R. venulosa* Berk. & Curt. and *R. fuliginosa* Berk. & Br. do not belong to the Mycetozoa (see Petch in Ann. Perad., iv. 311, 312).

Genus 36.—**LICEOPSIS** Torrend in Bull. Soc. Portug. Sci. Nat., ii. 63 (1908). Sporangia closely compacted, sessile, subglobose, with fragile membranous walls. Capillitium either consisting of slender branching threads and strands with membranous expansions at the axils, or wanting.

1. *L. lobata* Torrend l.c. Plasmodium watery-white. Sporangia closely clustered, rarely solitary, subglobose,

angled by mutual pressure, 0.4 to 0.7 mm. diam., rusty-brown, shining iridescent; sporangium-walls membranous, smooth. Capillitium scanty, consisting of slender rusty-brown branching and anastomosing threads and strands with thin membranous expansions. Spores subglobose or turbinate, rusty-brown, sharply and closely reticulated on two-thirds of their surface, faintly and loosely reticulated on the remaining third, 6 to 10  $\mu$  diam.—Torrend Fl. Myx., 121. *Reticularia lobata* Lister Mycetozoa, 161 (1894). *R. Rozeana* Lister in Journ. Bot., xxix. 263 (1891) *non* Rost.

Pl. 154.—*d.* clustered sporangia (England); *e.* capillitium; *f.* spores.

This species appeared in four successive years on a Spanish chestnut stump in Wanstead Park, Essex; it has also been obtained from near Woking, Berks, from Bedfordshire, Staffordshire, and Shropshire, from Argelées in the Pyrenees, and from Portugal. Gatherings made by Dr. Torrend on old willows, near Lisbon, show that the sporangia do not unite to form true aethalia, as they appear to do in some of the Wanstead specimens; in a few cases they are quite free, and may even be seated on slender stalks or strands of hypothallus. In spite of its small size and occasional free sporangia, *L. lobata* appears to be hardly more than a simple form of *Enteridium Rozeanum*; the spores of the two species are indistinguishable.

*Hab.* On dead wood.—Wanstead, Essex (B.M. 3197); Leighton, Beds (B.M. 1449); Pyrenees (B.M. 2829); Portugal (B.M. 2830)

#### Order V.—LYCOGALACEAE.

Sporangia forming an aethalium; pseudo-capillitium consisting of smooth or wrinkled branching (17) LYCOGALA. colourless tubes.

This order contains the single genus *Lycogala*.

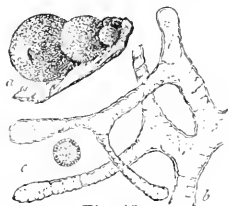


Fig. 45.

Fig. 45.—*Lycogala epidendrum* Fr.

*a.* Three aethalia. Natural size.

*b.* Capillitium. Magnified 150 times.

*c.* Spore. Magnified 600 times.

Genus 37.—LYCOGALA Adanson Fam. Pl., ii. 7 (1763). Aethalium subglobose or conical, with a cortex consisting of two or more closely combined layers of different structure; the outer layer is provided with large cell-like vesicles, which are either embedded or superficial; it is traversed by interlacing double-walled tubular threads that penetrate the homogenous inner layer at numerous points, their inner walls being continuous with the tubes of the pseudo-capillitium; the latter are grey or colourless, of wrinkled or nearly smooth branching tubes, attached to all parts of the cortex, with numerous rounded free ends.

The plasmodium of *Lycogala epidendrum* first rises from the wood as a group of small coral-red papillae, which as they grow unite to form a

cushion-like mass of closely convoluted sporangia; these are at first separated by delicate sporangium-walls, and narrow tubular air-passages communicating with the exterior are left between them. Sections of such an aethalium show that the sporangia in the deeper parts measure from 40 to 50  $\mu$  diam., while at the periphery they are continued into larger lobes having a diameter of 100  $\mu$ . At a later stage the outer convolutions become superficially subdivided, flattened and folded on themselves. The formation of this peripheral layer of larger lobes marks the first differentiation of the cortex of the aethalium. As maturation proceeds the limiting layer which at first invested the young sporangia disappears except in the interstices where it forms the membranous walls of the air-spaces and constitutes the pseudo-capillitium. At maturity the cortex is formed of two layers, an outer and an inner. The former bears on its surface thick-walled, isolated vesicles, 20 to 200  $\mu$  diam., containing nucleated deeply-staining protoplasm; the nuclei remain sharply defined till after the spores are formed in the aethalium, when they degenerate and disappear. Except for the contents of these vesicles, both layers of the cortex are free from nuclei. The protoplasm is withdrawn into the deeper parts of the aethalium from the wide peripheral lobes, and the tubular air-spaces between them fall together to form the matted layer recognizable at maturity in the hyaline outer wall of the cortex. The inner layer of the cortex consists of a finely granular membrane of varying thickness penetrated by air passages extending from the outer layer and becoming continuous with the pseudo-capillitium. The division of nuclei by karyokinesis prior to spore formation has been observed in the young aethalium of this species, and the resulting spores are found at maturity to be separated by tubular air-passages without any trace of true capillitium. In *L. flavo-fuscum* the membrane of the pseudo-capillitium is more delicate than in *L. epidendrum*, and is in some parts perforated with irregular lattice-work openings. The presence of spores in the tubes, which is occasionally found in *L. flavo-fuscum*, may be explained by the penetration of sporeplasm through such openings.

### KEY TO THE SPECIES OF *LYCOGALA*.

Cortex of aethalia smooth or areolated. 1. *L. flavo-fuscum*  
 Cortex of aethalia warted—

Aethalia subglobose. 2. *L. epidendrum*  
 Aethalia conical. 3. *L. conicum*

1. *L. flavo-fuscum* Rost. Versuch, 3 (1873). Plasmodium white or pale pink. Aethalia usually solitary, rounded, sessile, or subpyriform and shortly stalked, 2 to 5 cm. diam., ochraceous-brown or purplish-brown, smooth, minutely areolated; cortex thick, of three layers, the outer membranous, the middle consisting of a dense aggregation of yellow vesicles, 50 to 80  $\mu$  diam., intermixed with the peripheral ends of the pseudo-capillitial tubes, the inner layer homogeneous, pierced by these tubes. Pseudo-capillitium consisting of irregularly branching and anastomosing nearly colourless smooth or somewhat wrinkled papillose tubes, 6 to 20  $\mu$  diam., with numerous wide expansions at the axils and free rounded ends. Spores in mass pale buff,

when magnified colourless, minutely reticulated over the greater part of the surface, 5 to 6  $\mu$  diam.—Rost. Mon., p. 288; Mass. Mon., 124; Zopf in Schenk Handb. Bot., iii. pt. 2, 167; Macbr. N. Am. Slime-Moulds, 176. *Diphtherium flavo-fuscum* Ehrenberg Sylv. Myc. Berol., 14, 27 (1818). *Reticularia flavo-fusca* Fr. Syst. Myc., iii. 88 (1829). *R. testacea* Wallr. Fl. Crypt. Germ., 340 (1833) ?

Pl. 155.—*a.* aethalium; *b.* reticulated surface of cortex; *c.* vertical section of cortex; (1) outer layer composed of interwoven empty flattened tubes; (2) vesicles containing yellow or reddish-yellow matter, with the interspaces between them traversed by tubular processes which are more or less continuous with the pseudo-capillitium; (3) homogeneous inner layer, perforated by the pseudo-capillitium; *d.* pseudo-capillitium consisting of empty tubes, occasionally containing spores in the rounded ends and in limited spaces in the continuity of the tubes; two large isolated vesicles are also shown; *e.* part of pseudo-capillitium tube, showing a papillose surface; *f.* spores, showing unequally distributed reticulation; (North America).

In this species large isolated vesicles filled with granular matter and measuring from 50 to 100  $\mu$  diam. are often found scattered among the spores.

*Hab.* On dead wood.—New Forest, Hants (B.M. 2831); Amptill, Beds (B.M. 2832); Germany (B.M. 2836); Austria (B.M. 2834); Ceylon (K. 1732); Japan (B.M. 2833); Toronto, Canada (B.M. 2835); Philadelphia (B.M. slide); Ohio (B.M. slide); Iowa (B.M. 827); South Carolina (B.M. 838).

2. *L. epidendrum* Fries Syst. Myc., iii. 80 (1829). Plasmodium coral-red, rarely cream-coloured or yellow. Aethalia crowded or scattered, subglobose, sessile, 2 to 15 mm. diam., pinkish-grey, yellowish-brown, red-brown or nearly black, minutely warted; cortex varying in thickness, minutely warted with irregular superficial vesicles. Pseudo-capillitium arising from all parts of the inner side of the cortex in the form of loosely branching and anastomosing thin-walled tubes, varying from 3 to 20  $\mu$  diam., usually marked with close transverse wrinkles; free branches numerous, clavate or rounded at the ends; mass of pseudo-capillitium and spores pinkish grey or pink. Spores almost colourless, closely reticulated over the greater part of the surface, the remaining part marked with a loose reticulation or with short raised lines and warts, 4 to 7  $\mu$  diam.—Rost. Versuch, 3 (1873), & Mon., p. 285; Mass. Mon., 121; Macbr. N. Am. Slime-Moulds, 175. *Lycoperdon Epidendrum* Linn. Sp. Pl., 1184 (1753). *L. pisiforme* Jacq. Misc. Austr., i. 119 t. 7 (1778). *L. chalybeum* Batsch Elench. Fung., 155 (1783). *L. verrucosum* Batsch l.c. *Mucor Lycogala* Scop. Fl. Carn., ii. 496 (1772). *M. fragiformis* Schaeff. Fung. Bav., iv. no. 283 (1774). *Galoperdon epidendrum* Wiggers Fl. Holsat., 109 (1780). *Lycogala miniatum* Pers. in Roemer N. Mag. Bot., i. 87 (1794); Lister Mycetozoa, 209. *L. punctata* Pers. Syn., 158 (1801). *L. ferruginea* Schum. Enum. Pl. Saell., ii. 192 (1803). *L. cinerea* Schum. l.c., 193 ? *L. plumbea* Schum. l.c. ? *L. affine* Berk. & Br. in Journ. Linn.

Soc., xiv. 82 (1873). *L. exiguum* Morgan Myx. Miami Valley, 8 (1893); Macbr. N. Am. Slime-Moulds, 178. *Reticularia rosea* DC. in Bull. Soc. Philom., i. 105, fig. 8 A, B, C (1798). *R. miniata* Poiret. in Lam. Encycl., vi. 184 (1804). *R. punctata* Poiret l.c.

Var. *tessellatum* Lister in Penz. Myx. Buit., 77: aethalia dark brown, 2 to 10 mm. diam.; superficial vesicles of the cortex dark, lobed and flattened, divided by firm partitions into numerous chambers 20 to 50  $\mu$  diam.

PL 156.—*a.* aethalia; *b.* surface of cortex, warted with vesicles; *c.* vertical section of cortex; (1) upper layer containing interwoven thick-walled tubes, and bearing on the surface simple or compound vesicles; (2) homogeneous inner layer, perforated by the pseudo-capillitium; *d.* pseudo-capillitium, consisting of empty tubes, rugose with transverse folds; *e.* part of pseudo-capillitium tube, and spores; (England).

In small aethalia the cortex is usually thin, the interlacing threads in the outer layer narrow and scanty, and the homogeneous inner layer membranous; in larger aethalia the outer layer is often 40  $\mu$  thick, and the interlacing threads broad and abundant, with gelatinous outer walls 5 to 10  $\mu$  thick, while the homogeneous inner layer sometimes exceeds 50  $\mu$  in thickness. The colour of the spores varies from pinkish-grey to pink, fading to ochraceous. A remarkable form with small aethalia, 2 to 3 mm. diam., smooth pseudo-capillitium, and spores bright pink in mass was obtained in the province of Kii, Japan, by Mr. B. Nishino, who observed that the colour of the plasmodium was deep rose-red. Aethalia similar to those from Kii were gathered near New Haven, Conn., by Prof. Farlow. The characters distinguishing this form do not appear to be sufficiently constant to mark a separate variety, for smooth pseudo-capillitium may occur also in the var. *tessellatum*, and pink spores are sometimes seen in normal aethalia of *L. epidendrum*. *L. exiguum* Morg. would seem to be a small form of the present species; the spores are described as "pale ochraceous in mass."

*Hab.* On dead wood. Very common.—Wilts (B.M. 1c): Lyme Regis, Dorset (B.M. 1543); Orton Wood, Leicestershire (B.M. 1); Witley, Surrey (B.M. 2837); France (B.M. 733); Norway (B.M. 734); Finland (B.M. 732); Germany (B.M. 728); Switzerland (B.M. 2838); Italy (B.M. 737); Cape (B.M. 1554); Ceylon (B.M. 1563); Java (B.M. 2839); Christmas Island (B.M. 1744); Japan (B.M. 2028); Philippine Islands (B.M. 2037); Bermuda (B.M. 745); Philadelphia (B.M. 1544); Iowa (B.M. 1545); Antigua (B.M. 1692): var. *tessellatum*—Ceylon (B.M. 2840); Java (B.M. 2841); Cameroons (B.M. 2842); Philadelphia (B.M. 2843); Texas (B.M. 841A).

3. *L. conicum* Pers. Syn., i. 159 (1801). Plasmodium rose-red or scarlet. Aethalia conical, sessile on a broad base, crowded or scattered, 1.5 to 3 mm. high, 0.8 to 1.5 mm. broad, sometimes sub-globose, yellow-brown, marked with dark confluent superficial vesicles which form spots or a broken reticulation chiefly on the upper part; cortex thin, of two closely combined layers, the outer traversed by flattened tubes 2 to 10  $\mu$  broad; these are either loosely interlacing, or more often nearly parallel in a single series, and separated by intervals of 2 to 20  $\mu$ ; they pierce the membranous inner layer and are continuous with the pseudo-capillitium; the latter consisting of simple, rarely branching, olivaceous-

grey tubes, 3  $\mu$  diam., or varying from 2 to 7  $\mu$ , faintly and minutely wrinkled, with clavate or obtuse ends. Spores yellowish-grey or ochraceous, minutely reticulated over the greater part of the surface, 4 to 5  $\mu$  diam.—Fr. Syst. Myc., iii. 82; Mass. Mon., 123; Macbr. in N. Am. Slime-Moulds, 177; Petch in Ann. Perad., iv. 361. *L. nitidum* Berk. & Br. in Journ. Linn. Soc., xiv. 81 (1873). *L. atropurpureum* Berk. & Br. l.c., 82. *Dermodium conicum* Rost. Mon., p. 284 (1875).

Pl. 157.—*a.* aethalia; *b.* part of cortex; (1) outer membranous layer, bearing on the surface irregularly shaped vesicles containing dark granular matter, and traversed by empty flattened tubes having a somewhat parallel arrangement; (2) homogeneous inner layer, perforated by the narrow pseudo-capillitium tubes; *c.* part of pseudo-capillitium tube, and spores; (Ohio).

The aethalia in this species differ from those of *L. epidendrum* in the uniformly small size and more or less conical shape, in the scanty seldom branching somewhat parallel tubes of the thin outer layer of the cortex, and in the almost simple tubes of the pseudo-capillitium. Very similar structure is met with in minute thin-walled aethalia of *L. epidendrum*, but such small aethalia are usually found in company with others of more ordinary dimensions, and differ also in the shape and arrangement of the superficial vesicles.

*Hab.* On dead wood.—Switzerland (B.M. 2844); N. Germany (B.M. 2818); Ceylon (K. 1729); Japan (B.M. 2027); Santa Cruz, West Indies (B.M. 2845); Philadelphia (B.M. 1546); Ohio (B.M. slide).

*L. rufo-cinnamomeum* Mass., *L. ochraceum* Mass. and *L. Torrendii* Bres. belong to the *Hymenogastreae*, and not to the *Mycetozoa*; *L. terrestre* Fr. and *L. minutum* Sacc. and Paol. should probably be referred to the same group of fungi.

### Subcohort III.—CALONEMINEAE.

Sporangia simple; capillitium always present, forming a system of uniform threads; spores yellow, red, or grey.

#### Order I.—TRICHIACEAE.

Capillitium consisting of tubular threads that are either free and are then called "elaters," or combined into an elastic network; thickenings in the form of spirals or rings.

KEY TO THE GENERA OF TRICHIACEAE.  
Capillitium abundant, consisting of free elaters with spiral thickenings. (38) TRICHIA.

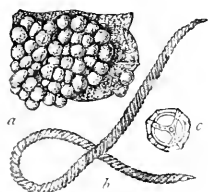


Fig. 46.

Fig. 46.—*Trichia affinis* de Bary.

*a.* Group of sporangia. Twice natural size.

*b.* Elater. Magnified 250 times.

*c.* Spore. Magnified 400 times.

Capillitium scanty, consisting of free elaters with imperfect spiral thickenings; sporangia minute, closely compacted or heaped.

(39) OLIGONEMA.

Fig. 47.—*Oligonema nitens* Rost.

- a. Cluster of sporangia. Magnified 3 times.  
b. Elater. Magnified 280 times.  
c. Spore. Magnified 400 times.

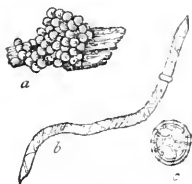


Fig. 47.

Similar to *Oligonema*, but the capillitium branching and anastomosing to form a network.

(40) CALONEMA.

Capillitium combined into a network, with spiral thickenings.

(41) HEMITRICHIA.

Fig. 48.—*Hemitrichia Vesparium* Macbr.

- a. Cluster of sporangia. Magnified  $2\frac{1}{2}$  times.  
b. Capillitium. Magnified 280 times.  
c. Spore. Magnified 400 times.

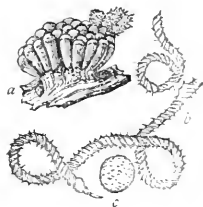


Fig. 48.

Capillitium combined into a network, with thickenings in the form of rings.

(42) CORNUVIA.

Fig. 49.—*Cornuvia Serpula* Rost.

- a. Plasmodiocarp. Magnified 7 times.  
b. Capillitium. Magnified 250 times.  
c. Spore. Magnified 400 times.

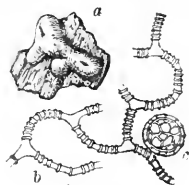


Fig. 49.

Genus 38.—**TRICHIA** Haller Hist. Stirp. Helv., iii. 114 (1768). Sporangia stalked or sessile; sporangium-wall membranous or cartilaginous; elaters free, pointed at each end, thickened with two to five spiral bands; spores reticulated or warted, in the former case the reticulation may be continuous or broken, and forms when seen in profile a "border" to the spore.

## A. Spores more or less completely reticulated :—

Elaters 7 to 8  $\mu$  wide ; spores reticulated ; border 2  $\mu$  wide ; sporangia sessile. 1. *T. favoginea*

Elaters 4 to 5  $\mu$  wide ; spores reticulated with narrow bands ; border 1  $\mu$  wide ; sporangia stalked, clustered. 2. *T. verrucosa*

Elaters 4 to 6  $\mu$  wide ; spores reticulated with broad pitted bands ; border 0.5 to 1  $\mu$  wide ; sporangia sessile. 3. *T. affinis*

Elaters 4 to 6  $\mu$  wide ; spores with the reticulation more or less broken into irregular shallow pitted warts ; border interrupted, 0.5  $\mu$  wide ; sporangia sessile. 4. *T. persimilis*

Elaters 4 to 6  $\mu$  wide ; spores very closely reticulated ; border none ; sporangia sessile. 5. *T. scabra*

B. Spores minutely warted (sometimes minutely reticulated in *T. decipiens*) :—

a. Spirals of elaters two. 6. *T. varia*

b. Spirals of elaters three or more—

a. Elaters shortly tapering at the ends—

Sporangia sessile ; wall uniformly thickened with granular matter ; spirals of elaters distinct or faint. 7. *T. contorta*

Sporangia sessile ; wall without granular thickening ; spirals of elaters faint. 8. *T. lutescens*

Sporangia stalked ; wall membranous, thickened in rounded areas with brown granular deposits ; elaters spinose. 9. *T. erecta*

Sporangia stalked ; elaters smooth. 12. *T. subfusca*

$\beta$ . Elaters smooth, very gradually tapering at the ends ; sporangia stalked—

Stalk filled with spore-like cells.

10. *T. decipiens*

Stalk almost solid, not filled with spore-like cells.

11. *T. Botrytis*

1. *T. favoginea* Pers. in Roemer N. Mag. Bot., i. 90 (1794). Plasmodium white (or yellow, *fide* Macbride). Sporangia sessile, globose, ovoid, or clavate, crowded on a membranous hypothallus, 0.6 to 0.7 mm. broad, 0.7 to 1.9 mm. high, ochraceous-



yellow; mass of spores and capillitium orange-yellow; sporangium-wall membranous, thickened with delicate irregular striae. Capillitium consisting of long cylindrical elaters 7 to 8  $\mu$  diam., smooth or with scattered spines, thickened with four to five spiral bands 1  $\mu$  broad, the intervals 1 to 2  $\mu$ , crossed by slender ridges running parallel with the length of the elater and connecting the bands; the ends of elaters conical, terminating in a smooth point 3 to 8  $\mu$  long. Spores yellow, the wall reticulated with narrow deep bands forming a net with three to five meshes to the hemisphere, 13 to 15  $\mu$  diam. including the border of 1.6 to 2  $\mu$  width.—Schum. Enum. Pl. Saell., ii. 207 (1803); Macbr. N. Am. Slime-Moulds, 214. *Lycoperdon favogineum* Batsch. Elench. Fung., Cont. 257 (1786). *Clathrus turbinatus* Huds. Fl. Angl., ii. 632 (1778)? *Stemonitis favoginea* Gmel. Syst. Nat., ii. 1470 (1791). *Sphaerocarpus chrysospermus* Bull. Champ., t. 417, f. 4 (1791). *Trichia nitens* Pers. Obs. Myc., i. 62 (1796). *T. ovata* Pers. l.c., 61? *T. turbinata* Sow. Engl. Fung., t. 85 (1799)? *T. chrysosperma* DC. Fl. Fr., ii. 250 (1805); Rost. Mon., p. 255; Mass. Mon., 189.

Pl. 159.—a. sporangia; b. two spores and part of elater; (Freiburg, Germany).

The species of *Trichia* with reticulated spores are separated from each other by somewhat arbitrary lines, owing to the inconstancy of the distinctive characters. The descriptions under the several names are here given from the specimens named by Rostafinski in the Strassb. Herb.; they represent well marked centres, but in this abundant and widespread genus forms are of frequent occurrence which take an intermediate position. The character of longitudinal striae connecting the bands on the elaters is met with to a greater or less extent in each member of the group. In extensive gatherings of the present species on old pine stumps in the Black Forest, the elaters are nearly regular in breadth, usually 8  $\mu$  diam., but some measure 7  $\mu$  and some 6.5  $\mu$ ; the connecting striae are almost always but not invariably distinct; the spores have mostly unbroken bands without pits, and show a border 2  $\mu$  diam.; in some parts of several gatherings the bands are broader, broken and pitted, and so shallow that the border is reduced to a slight thickening of the spore-wall; but in all these specimens a considerable part retains the character of *T. favoginea* in the narrow and even bands on the spores and broad elaters. American gatherings show similar variation; sometimes, with spores having regular reticulation and narrow bands, the elaters are only 6  $\mu$  diam. Between *T. favoginea* and *T. affinis*, *T. affinis*, and *T. persimilis* and *T. persimilis* and *T. scabra*, intermediate forms frequently occur. The length, branching, and markings of the elaters vary much with different conditions of development. A gathering of *Hemitrichia chrysospora* List. has been found at Lyme Regis of the *Trichia* form with free elaters; an abnormal form of *T. scabra* has occurred with the capillitium consisting of a dense network of the extreme *Hemitrichia* type with no free elaters. *T. affinis* and *T. scabra*, when exposed to severe changes of temperature, at the time of their fruiting, have developed elaters with the

spirals to a great degree modified into complete rings, approaching the markings on the elaters of *Cornuvia Serpula*; and *T. persimilis* under similar conditions has produced very short elaters with broad rings and faint spirals of much the same character as in *Oligonema nitens* (cp. Introduction, 16). With such blending of form, which indicates a close relationship between all these species, the characters given in the key must be taken as approximate, marking the main centres around which the numerous varieties group themselves.

*Hab.* On dead wood.—Bulstrode, Bucks (B.M. 1114); Sutton, Warwick (B.M. slide); Sweden (K. 1179); Baden Baden (B.M. 1451); Salem, Germany (B.M. 777); Zürich, Switzerland (B.M. 1140); Poland (Strassb. Herb.); Austria (B.M. 1829); Italy (B.M. 1952); Portugal (B.M. 2847); Philadelphia (B.M. slide); Maine, U.S.A. (B.M. 1616); Georgia (B.M. 2849); Iowa (B.M. 2848).

2. *T. verrucosa* Berk. in Hooker Fl. Tasm., ii. 269 (1860). Plasmodium white. Total height 2 to 4 mm. Sporangia stalked, rarely sessile, pyriform or clavate, clustered or solitary, 1.4 mm. high, 0.8 mm. broad, ochraceous-yellow, mass of elaters and spores golden-yellow; sporangium-wall membranous, minutely and closely papillose on the inner side pale yellow, sometimes with an outer layer thickened by granular deposits. Stalks membranous, 1 to 2 mm. high, usually combined in clusters of three or four, rugose, yellow-brown, or dark brown. Capillitium of long cylindrical elaters, 4 to 6  $\mu$  wide, with short conical ends, marked with three to five narrow spiral bands, smooth, or with a few scattered spines; longitudinal striae distinct. Spores reticulated with narrow, minutely pitted bands, forming a network with about seven meshes to the hemisphere, 13 to 16  $\mu$  diam.; border 1  $\mu$  wide.—Mass. Mon., 191; Macbr. N. Am. Slime-Moulds, 215; Torrend Fl. Myx., 111. *T. superba* Mass. in Journ. R. Micr. Soc., 1889, 345; Mass. Mon., 194.

Pl. 161.—a. cluster of sporangia; b. elater and spore; (Java).

Berkeley's type from Tasmania (K. 17750) is somewhat immature, but is sufficiently developed to be clearly identified as the same species as *T. superba* Mass. from New Zealand. A fine specimen of the same form from Chili, in the Strassburg Herb., is named by Rostafinski *T. chrysosperma* (syn. *T. favoginea*); *T. verrucosa* is no doubt closely allied that species, but the constancy of the characters of the stalked sporangia and of the spores marked with a rather close reticulation of narrow bands forming a border scarcely 1  $\mu$  broad supports the specific distinction.

*Hab.* On dead wood.—Oxshott, Surrey (B.M. 2850); North Wales (B.M. 2851); Moffat, Scotland (B.M. 1452); Portugal (B.M. 2852); Java (B.M. 2853); Tasmania (K. 1750); New Zealand (K. 1166); Japan (B.M. 2854); Dominica (B.M. 1753); Washington State (B.M. 2855); Brazil (B.M. 2856); Chili (Strassb. Herb.).

3. *T. affinis* de Bary in Fuckel Symb. Myc., 336 (1869). Plasmodium watery-white. Sporangia globose or obovoid, sessile, usually crowded, often seated on a membranous hypothallus, 0.6 to 1 mm. diam., shining golden or ochraceous-yellow; mass of elaters and spores bright yellow; sporangium-wall membranous, pale yellow, marked with delicate irregular striae, rarely reticulated in a manner resembling fan-tracing. Capillitium consisting of long cylindrical elaters, 4 to 6  $\mu$  diam. with conical pointed ends, marked with four to five spiral bands, smooth, rarely studded with minute scattered spines; longitudinal striae usually present. Spores reticulated with broad, rarely narrow, pitted bands, forming a more or less complete net with three to five meshes to the hemisphere, 13 to 15  $\mu$  diam.; border 0.5 to 1  $\mu$  wide.—Rost. Mon., p. 257; Mass. Mon., 194. *Trichia Kalbreyeri* Mass. in Journ. R. Micr. Soc., 1889, 344; Mass. Mon., 191. *Trichia intermedia* Mass. in Journ. R. Micr. Soc., 1889, 341; Mass. Mon., 188. *Trichia pulchella* Rex in Proc. Acad. Nat. Sci. Phil., 1893, 366; Macbr. N. Am. Slime-Moulds, 215. *T. persimilis* Macbr. l.c., 213, in part.

Pl. 160.—c. sporangia; d. spores and elaters, one elater showing regular the other irregular spiral bands; (England).

This species is nearly allied to *T. persimilis*, with which it is united by Prof. Macbride; in Europe and the British Isles, however, the two centres are usually well distinguished. The type of *T. pulchella* Rex, from Philadelphia (B.M. slide), differs from the usual developments of *T. affinis* in the more scattered habit of growth of the sporangia; the elaters are narrow, being 3.5 to 4.5  $\mu$  diam.; the spores have a border 1  $\mu$  wide and are reticulated with narrow, minutely pitted raised bands, presenting from three to four meshes on the hemisphere; it can hardly be considered as having distinctive specific characters. The type of *T. Kalbreyeri* Mass., from New Granada (K. 1196), has elaters 5  $\mu$  diam., with delicate longitudinal striae, and spores marked with a rather close reticulation of broad, faintly pitted bands; it does not appear to differ from typical *T. affinis*. The type of *T. intermedia* Mass. from Scarborough has elaters 4 to 6  $\mu$  diam., and is almost identical with de Bary's type of *T. affinis* in the Strassburg Herbarium both in capillitium and spores.

*Hab.* On dead wood, moss, etc. Common in the British Isles.—Addington, Surrey (B.M. 362); Leicestershire (B.M. 363A); Wanstead, Essex (B.M. 1454); Lyme Regis, Dorset (B.M. 1453); Falmouth, Cornwall (B.M. 2857); North Wales (B.M. 2858); Edinburgh (K. 1180); Ireland (B.M. slide); Germany (B.M. 785); Sweden (B.M. 2859); Switzerland (B.M. 2860); Portugal (B.M. 2861); Ceylon (B.M. 2862); Australia (B.M. slide); Philippine Islands (B.M. 2047); New Zealand (B.M. 2866); Japan (B.M. 2867); Washington State (B.M. 2863); Iowa (B.M. 834); Philadelphia (B.M. slide); South Carolina (B.M. 959); Colorado (B.M. 2864); Cuba (K. 1118); New Granada (B.M. slide); Brazil (B.M. 2865); Chili (Paris Herb.).

4. *T. persimilis* Karst. in Not. Saellsk. pro Fauna et Flora Fenn. Forh., ix. 353 (1868). Plasmodium watery-white. Sporangia globose, usually crowded and seated on a common membranous hypothallus, 0.5 to 0.8 mm. diam., brown or yellow-brown, shining; capillitium and spores in mass yellow or yellow-brown; sporangium-wall membranous, yellow, marked with delicate "stippled" lines or rows of minute warts. Capillitium of cylindrical elaters 4 to 6  $\mu$  diam., marked with about four closely set spiral bands, usually studded with numerous short slender spines; the ends of the elaters conical, acute, or with the spiral bands produced at the apex into two or three diverging points; longitudinal striae inconspicuous. Spores yellow, or yellow-brown, 11 to 14  $\mu$  diam., with the reticulation broken, or represented by irregular pitted warts; border interrupted.—Macbr. N. Am. Slime-Moulds, 213, in part. *T. Jackii* Rost. Mon., p. 258 (1875); Mass. Mon., 188. *T. proximella* Karst. in Bidr. Känn. Finl. Nat., iv. 139 (1879); Mass. Mon., 180. *Trichia abrupta* Cooke in Ann. Lyc. Nat. Hist. N. York, xi. 404 (1877); Mass. Mon., 187. *Trichia Balfourii* Mass. in Journ. R. Mier. Soc., 1889, 339; Mass. Mon., 186. *Trichia sulphurea* Mass. in Journ. R. Mier. Soc., 1889, 339; Mass. Mon., 186.

Pl. 160.—*a.* sporangia; *b.* elater and spores; (England).

This abundant species is closely allied to both *T. affinis* and *T. scabra* (*q.v.*). The capillitium, when matured under unfavourable conditions, often shows great divergence from the usual type. The elaters in some cases are very short, measuring only 12 to 15  $\mu$  in length; in others they may be long, branched and combined to form a *Hemitrichia*-like network. Dr. Karsten's type from Finland, agrees essentially with the examples of *T. Jackii* Rost. in Strassb. Herb.; the latter name must therefore be dropped as being ante-dated. The occurrence of the long spinous processes on the elaters, noted in the original description of *T. persimilis*, is not a constant character. A form with the ends of the elaters obtuse and the spiral bands continued at the apex into widely diverging spines, has been named *T. abrupta* Cooke, but this character is also found occasionally in *T. javoginea*, *T. affinis*, and *T. scabra*. *T. proximella* Karsten and *T. sulphurea* Mass. have elaters 4.5 to 5  $\mu$  diam., and spores with the bands much broken; *T. Balfourii* Mass. has the elaters 4 to 5  $\mu$  diam., and the reticulation on the spores consists of wide, broken and pitted bands. They present no character by which they can be separated from *T. persimilis*.

*Hab.* On dead wood, leaves, etc.—Lyme Regis, Dorset (B.M. 1457); Batheaston, Somerset (B.M. 367); Penzance (B.M. 370); Wanstead, Essex (B.M. 1458); Birmingham (B.M. 1459); Boynton, Yorks (B.M. 1125); Glamis, Scotland (B.M. 369); Germany (B.M. 2254); France (K. 1183); Sweden (B.M. 2868); Finland (B.M. slide); Switzerland (Zürich Herb.); Portugal (B.M. 2869); Ceylon (K. 1749) Cape (K. 1047); Java (K. 1755); New Zealand (B.M. 2870); Muskoka,

Canada (B.M. 2871); Maine, U.S.A. (B.M. 1617); Philadelphia (B.M. 1903A); Colorado (B.M. 2872); Peru (B.M. 2873).

5. *T. scabra* Rost. Mon., p. 258 (1875). Plasmodium watery-white. Sporangia sessile, globose, usually crowded and seated on a membranous hypothallus, 0.6 to 0.9 mm. diam., shining, orange-yellow, olivaceous or yellow-brown; sporangium-wall membranous, yellow, marked with faint lines of minute warts. Capillitium and spores in mass bright orange-yellow. Capillitium of long cylindrical bright yellow elaters, 4 to 6  $\mu$  diam., marked with four or five often somewhat irregular spiral bands, studded with spines or nearly smooth, the ends acutely conical or with the bands produced at the apex in more or less diverging points; longitudinal striae rarely evident. Spores yellow, minutely and closely reticulated with shallow bands forming a complete or fragmentary net with about forty meshes to the hemisphere, rarely irregularly warted, 9 to 12  $\mu$  diam.—Mass. Mon., 192; Macbr. N. Am. Slime-Moulds, 213. *Trichia minima* Mass. in Journ. R. Micr. Soc., 1889, 336; Mass. Mon., 182. *Trichia nitens* Fries in MS.; Mass. in Journ. R. Micr. Soc., 1889, 333; Mass. Mon., 179. *Arcyria Bucknalli* Mass. l.c., 161. *Oligonema aeneum* Karst. in Bidr. Känn. Finl. Nat., iv. 131 (1879)? *Cornuvia anomala* Karst. l.c.? *O. fulvum* Morg., Myx. Miami Valley, 42 (1893). *Ophiotheca anomala* Mass. l.c., 135?

Pl. 159.—c. sporangia (England); d. spores and elaters; one of the latter shows regular, the other irregular spiral bands.

The type of *Arcyria Bucknalli* Mass., from Bristol (K. 1774), is an interesting form of the present species; the capillitium is spinose, and consists of long sparingly branched free elaters, not combined into a network; the spiral bands are in many parts entirely modified into rings, a character which is often seen in some degree in imperfect developments of this species; the spores are of the typical form of *T. scabra*. A specimen from Luton (B.M. slide) has the dense net of a *Hemitrichia* and no free elaters; the close and rugged spirals on the threads have in some parts an annular arrangement; it is, however, an undoubted form of the present species; the spores are typical. The type of *T. minima* Mass., from Oldham (K. 1044), has spinulose elaters 4 to 5  $\mu$  diam.; the spores measure 9  $\mu$ ; some are delicately reticulated, in others the net is broken into warts and short bands; it is not an unusual form of *T. scabra*. The type of *T. nitens* Fr. from Upsala (K. 1104) has spores 9 to 10  $\mu$  diam., for the most part closely reticulated, but some have the bands much broken; the elaters measure 4 to 5  $\mu$  diam., with regular spiral bands and only a few short scattered spines; it appears to be a typical form of *T. scabra*, except that the elaters are rather more smooth than usual. The type of *Oligonema fulvum* Morgan, from Preston, Ohio (B.M. slide) is also *T. scabra*; the scanty capillitium consists of short, rather irregularly formed elaters, some of which have the usual spiral markings, while others are nearly or quite smooth; the sporangium-walls are beautifully iridescent; the spores are marked with the characteristic close reticulation, and measure 10 to 13  $\mu$  diam.

The type of *Oligonema acenum* Karst. from Finland, is not represented in the quoted collections; the description of the crowded olivaceous sporangia, smooth elaters marked with scattered ring-shaped thickenings, and warted, yellowish-ochre spores, suggests an irregular development of the present species. The description of *Trichia anomala* Karst. (syn. *Cornuvia anomala* Karst.) also suggests an abnormal growth of *T. scabra*.

*Hab.* On dead wood. Common.—Wotthorpe, Northants (B.M. 366); Somerset (B.M. 368); Wanstead, Essex (B.M. 1462); Lyme Regis, Dorset (B.M. slide); Dudley, Stafford (B.M. 1461); Alnwick, Northumberland (B.M. 2875); Scotland (B.M. 2876); Norway (B.M. 2877); Sweden (K. 1104); Germany (B.M. 779); Poland (Strassb. Herb.); Switzerland (B.M. 2878); Austria (B.M. 1834); Portugal (B.M. 2879); Ceylon (B.M. 2890); Banff, Canada (B.M. 2891); Muskoka, Canada (B.M. 2892); Washington State (B.M. 3191); Iowa (B.M. 835); Ohio (B.M. 1464); Maine, U.S.A. (B.M. 1618); Philadelphia (B.M. 1463).

6. *T. varia* Pers. in Roemer N. Mag. Bot., i. 90 (1794). Plasmodium white. Sporangia globose, ovoid or turbinate, 0.6 to 0.9 mm. diam., sessile, stalked, or forming short plasmodiocarps, crowded or scattered, ochraceous or olivaceous; sporangium-wall membranous, pale yellow, marked with ring-shaped or crescentic thickenings 8  $\mu$  diam. Stalks 0.1 to 0.5 mm. high, 0.2 to 0.3 mm. thick, black, furrowed. Capillitium of cylindrical ochraceous-yellow elaters, 3 to 5  $\mu$  diam., tapering shortly at the ends and terminating in a curved point, marked with two prominent spiral bands more prominent on one side of the elater than on the other. Spores ochraceous-yellow, minutely warted, 11 to 16  $\mu$  diam.—Rost. Mon., p. 251; Mass. Mon., 178; Macbr. N. Am. Slime-Moulds, 212. *Stemonitis varia* Pers. in Gmel. Syst. Nat., 1470 (1791). *Mucor pyriformis* Scop. Fl. Carn., ed. 2, ii. 492 (1772)? *Lycoperdon vesiculosum* Batsch Elench. Fung., Cont. i. 283 (1786)? *Trichia olivacea* Pers. Obs. Myc., i. 62 (1796)? *T. vulgaris* Pers. l.c., ii. 32 (1799)? *T. cordata* Pers. l.c., 33. *T. cylindrica* Pers. l.c. *T. pyriformis* Pers. l.c. *T. nigripes* Pers. Syn., 178 (1801). *T. craterioides* Corda Icon., ii. 21, t. xii., f. 85 (1838). *T. aculeata* Cel. fil. Myx. Böhm., 34 (1893).

Pl. 164.—*a.* sporangia; *b.* elater; *c.* spore; (England).

Sporangia with longer or shorter stalks frequently occur with sessile forms arising from the same plasmodium. As in other species of the genus, forms of *T. varia* sometimes occur with either very long (cp. *T. varia* v. *aurata* Meylan in Bull. Soc. Vaud., xlv. 299), or very short elaters, or the elaters may branch and combine to form a *Hemitrichia*-like network. The type of *T. aculeata* Cel. fil., from Bohemia (B.M. 2893), is a somewhat irregular form of the present species; many of the elaters are very short, and show attachment to the sporangium-wall; they are then either marked with the usual spiral bands, or are smooth and reduced to spine-like processes.

*Hab.* On dead wood. Common.—Batheaston, Somerset (B.M. 361); Lyme Regis, Dorset (B.M. 1466); Wilts (B.M. 1465); Hampstead (B.M. 1122); Brandon, Suffolk (B.M. 1121); Cheshire (B.M. 1117); Northumberland (B.M. 2894); France (B.M. 2895); Germany (B.M. 2271); Switzerland (B.M. 1141); Finland (K. 1124); Italy (K. 1148); Bohemia (B.M. 2893); Portugal (B.M. 2896); Ceylon (Peradeniya Herb.); Banff, Canada (B.M. 2897); Washington State (B.M. 2898); Iowa (B.M. 1466B); Philadelphia (B.M. 1889); Colorado (B.M. 2899); South Carolina (B.M. 800).

7. *T. contorta* Rost. Mon., p. 259 (1875). Plasmodium watery-white. Sporangia crowded or scattered, subglobose, 0.5 to 0.8 mm. diam., sessile, often forming elongated curved plasmodiocarps, rarely provided with a very short black stalk, dull yellow-brown or dark red-brown; sporangium-wall membranous or cartilaginous, yellow, or reddish-brown, charged with brown granular matter, rarely with deposits of angular crystals of lime, when the sporangia are grey. Capillitium of cylindrical simple or branched elaters, with four or five often indistinct or rugged spiral bands, 3 to 5  $\mu$  diam., the tips usually swollen and ending in a curved point, yellow or yellow-brown. Spores yellow, minutely spinulose, 10 to 14  $\mu$  diam.—Mass. Mon., 182; Macbr. N. Am. Slime-Moulds, 210. *Lycogala contortum* Ditm. in Sturm Deutsch. Fl., Pilze, 8, tab. 5 (1813). *Perichaena contorta* Fr. Syst. Myc., iii. 192 (1829). *Licea contorta* Wallr. Fl. Crypt. Germ., ii. 345 (1833). *Trichia reniformis* Peck in Rep. N. York Mus., xxvi. 76 (1874). *T. heterotrichia* Balf. in Grev., x. 117 (1881). *T. iowensis* Macbr. in Bull. Nat. Hist. Iowa, ii. 133 (1892). N. Am. Slime-Moulds, 211. *T. pachyderma* Cel. fil. Myx. Böhm., 38 (1893). *T. intermedia* Cel. fil. l.c. *T. ovalispora* Hollós in Math. Nat. Wiss. Ber. Ung., xx. 324 (1905)? *Oligonema fulvum* Pav. & Lag. in Bull. Soc. Myc., Fr., xix. 99 (1903) (*non* Morgan).

Var. 1.—*inconspicua* Lister: elaters regular, cylindrical, often swollen behind the gradually tapering pointed ends; spiral bands distinct, close and regular.—*T. inconspicua* Rost. Mon., p. 259 (1875); Mass. Mon., 180; Macbr. N. Am. Slime-Moulds, 210. *T. advenula* Mass. in Journ. R. Micr. Soc., 1889, 336; Mass. Mon., 181. *T. Andersoni* Rex in Proc. Acad. Nat. Sci. Phil., 1891, 395. *T. Rostafinskii* Cel. fil. l.c., 37.

Var. 2.—*alpina* R. E. Fries in Arkivför Bot., vi. no. 7, p. 5 (1906): sporangia globose or forming elongated and curved plasmodiocarps, brownish-purple or black; sporangium-wall cartilaginous, red- or olive-brown; elaters yellow, with regular or rugged and sometimes spinose spiral bands; spores yellow, minutely spinulose, 13 to 20  $\mu$  diam.—Lister in Journ. Bot., xlv. 219.

Pl. 162.—*a.* sporangia; *b.* fragment of sporangium-wall, spores, and portions of two elaters, one with irregular spirals, the other, var. *inconspicua*, with regular spirals (England); *c.* sporangia, var. *alpina* (Switzerland); *d.* fragment of sporangium-wall, spores, and portions of three elaters of var. *alpina*.

Intermediate forms connecting the var. *inconspicua* with the typical form are of frequent occurrence, and the variations of capillitium described above have on several occasions been found represented in different sporangia of the same group. The sporangium-wall varies from yellow-brown, rosy brown to purplish-brown; occasionally it is whitish-lilac from deposits of angular crystals of lime, as in forms of some species of *Perichaena*, while in the remarkable alpine form, var. *alpina*, it is purplish-black. *T. reniformis* Peck, of which a typical specimen has been received from Dr. Rex, has the granular thickening of the sporangium-wall and the rugged irregular spirals of typical *T. contorta*. A type specimen of *T. Andersoni* Rex from Sand Coulee, Montana, has most of the elaters with regular close spiral bands but in some the spirals are rugged or even absent; the brown granules in the sporangium-wall are less abundant than is usual in *T. contorta*, but this character does not seem to be sufficiently important to separate *T. Andersoni* from the present species. The type of *T. advenula* Mass., from Glamis (K. 1748), has the sporangium-wall charged with brown granular matter and the spirals on the elaters are regular and distinct; it is similar to Rostafinski's type of *T. inconspicua* in Strassb. Herb. *T. heterotrichia* Balf., from Currey's collection (K. 1066), appears to be an immature specimen of *T. contorta*; the sporangium-walls are almost free from granular deposits; the elaters are 4 to 5  $\mu$  diam., marked with one or three rugged or indistinct spiral bands, and scattered blunt spines; the spores adhere to one another, and are very faintly spinulose; they measure 12 to 13  $\mu$ . *T. iowensis* Macbride agrees with the present species in the habit and colour of the sporangia, in the granular sporangium-wall, and in the spores; the elaters are 3  $\mu$  diam., and, in addition to being marked with about four inconspicuous spiral bands, are studded with numerous slender flexuose spines 5 to 10  $\mu$  long; the presence of spines is not of rare occurrence on the elaters of *T. contorta*. *T. pachyderma* Cel. fil. is a form of the present species with thick-walled elaters marked with faint spiral bands. *T. intermedia* Cel. fil. combines the characters of typical *T. contorta* and the var. *inconspicua*. *T. Rostafinskii* Cel. fil. is the var. *inconspicua*, with both sessile and shortly stalked sporangia. *T. ovalispora* Hollös, from Hungary, may possibly be a form of the present species; oval spores are met with occasionally in many species of the genus *Trichia*.

Forms of *T. contorta* having the elaters branched and combined into a network are so frequent that for convenience of reference they are placed in the genus *Hemitrichia* under the name *H. Karstenii* Rost.

*Hab.* On dead bark and wood. Not uncommon.—Lyme Regis, Dorset (B.M. 1467); Wanstead, Essex (B.M. 1468); Reigate, Surrey (B.M. 2900); Aberdeen (B.M. slide); France (K. 997); Germany (K. 1771); Poland (Strassb. Herb.); Bohemia (B.M. 2901); Washington State (B.M. 2902); Montana (B.M. slide); Colorado B.M. 2903); var. *inconspicua*—Batheaston, Somerset (B.M. 351); Alresford, Hants (B.M. 2904); Ashridge, Herts (B.M. 2905); Brechin, Scotland (B.M. 365); Norway (Christiania Herb.); Sweden (K. 1702); North Germany (B.M. 2906); Switzerland (Strassb. Herb.); Bohemia



(B.M. 2907); Iowa (B.M. slide); New York (B.M. slide); New Hants (B.M. 2908): var. *alpina*—Sweden (B.M. 2909); Switzerland (B.M. 2901); Lower Austria (B.M. 3205).

**S. T. lutescens** Lister in Journ. Bot., xxxv. 216 (1897). Plasmodium? Sporangia sessile, scattered or in small clusters, globose or bolster-shaped, 0.15 to 0.7 mm. diam., shining, bright yellow or olivaceous-yellow; sporangium-wall membranous, yellow, entirely free from granular deposits, often embossed with the impression of the underlying spores. Capillitium consisting of short or long, simple or branching pale yellow elaters, 0.3 to 0.45  $\mu$  diam., marked with four to five distinct or often faint spiral bands, either tapering or blunt and bulbous at the tips. Spores bright or olivaceous yellow, closely warted or spinulose, 10 to 12  $\mu$  diam.—Torrend Fl. Myx., 116. *Oligonema furcatum* Buckn. in Mass. Mon., 173 (1892). *Trichia contorta* var. *lutescens* Lister Mycetozaa, 169 (1894).

Pl. 161.—c. sporangia (Yorks); d. elaters and fragment of sporangium-wall; e. tip of elater and spores.

This species is closely allied to *T. contorta* from which it is distinguished by the delicate sporangium-wall being translucent and entirely free from granular deposits. An abnormal form was found by Dr. R. E. Fries near Upsala (B.M. 2915), having yellowish-brown sporangia varying in size from 0.3 to 0.7 mm. diam.; some elaters are short and simple, others branch and anastomose, and show many spherical or irregular expansions and blunt spine-like processes. Numerous gatherings of *T. lutescens* have been made by Dr. Torrend, near Lisbon; in one of them the long elaters are combined to form a network; this has been placed by Dr. Torrend under *Hemitrichia Karstenii* as var. *lutescens* nov. var. (Bull. Soc. Port. Sc. Nat., ii, 61). Bucknall's earlier specific name is not here revived as the combination *Trichia furcata* was previously given by Wigand to what appears to be a small form of *T. decipiens*.

*Hab.*—On dead wood.—Abbots Leigh, Somerset (B.M. 2911); Yorks (B.M. 2912); Berlin (B.M. 2913); Norway (B.M. 2914); Sweden (B.M. 2915); Portugal (B.M. 2916).

**9. T. erecta** Rex in Proc. Acad. Nat. Sci. Phil., 1890, 193. Plasmodium? Total height 1 to 2 mm. Sporangia scattered, stalked or nearly sessile, globose or subtorbinate, 0.5 to 0.7 mm. diam., bright yellow, mottled with well-defined dark brown angular patches; sporangium-wall membranous, pale yellow, densely charged with brown angular matter in the dark patches. Stalk cylindrical, 0.5 to 1 mm. high, 0.2 to 0.3 mm. thick, dark brown, opaque. Capillitium of cylindrical bright yellow elaters, 3.5 to 4  $\mu$  diam., with short tapering ends; marked with four bands forming a close irregular spiral, studded with numerous spines. Spores yellow, delicately warted, 11 to 13  $\mu$  diam.—Mass. Mon., 184; Macbr. N. Am. Slime-Moulds, 218.

Pl. 158.—e. sporangia; f. elater; g. spore; (United States).

A single specimen of what appears to be this species has been found at Lyme Regis, agreeing in every respect with the type received from Dr. Rex, except that the stalk is very short, 0.5 mm. high.

*Hab.* On dead wood.—Lyme Regis, Dorset (B.M. slide); Adirondack Mountains, New York (B.M. 1898).

10. *T. decipiens* Macbr. N. Am. Slime-Moulds, 218 (1899). Plasmodium rose-coloured or white. Total height 1.5 to 3 mm. Sporangia stalked, gregarious, turbinate, 0.6 to 0.8 mm. diam., shining olive or yellow-brown; sporangium-wall yellow, membranous, of two layers. Stalk cylindrical furrowed, 0.5 to 1 mm. long, olive or dark brown, filled to the base with spore-like cells. Capillitium of simple or branched smooth olive-brown elaters, 4.5 to 5.5  $\mu$  diam., marked with four or five spiral bands, 0.5 to 1  $\mu$  broad, with intervals of 0.5 to 2  $\mu$ , gradually tapering into long slender points. Spores yellow-brown, minutely warted, or very closely and often irregularly reticulated on one side, 9 to 12  $\mu$  diam.—*Arcyria decipiens* Pers. in Ust. Ann. Bot., xv. 35 (1795). *Trichia fallax* Pers. Obs. Myc., i. 59 (1796); Rost. Mon., p. 243; Mass. Mon., 192; Lister Mycetozoa, 170. *T. virescens* Schum. Enum. Pl. Saell., ii. 208 (1803). *T. cerina* Ditm. in Sturm Deutsch. Fl., Pilze, 51, t. 25 (1817). *T. fulva* Purt. Midl. Fl., iii. 290 (1821). *T. clavata* Wigand in Pringsh. Jahrb. Bot., iii. 28 (1863)? *T. furcata* Wigand l.c., 29, t. 1, fig. 1 to 11. *T. obtusa* Wigand l.c., 30? *T. nana* Zukal in Verh. Zool.-Bot. Gesell. Wien, xxxv. 334, t. xv, f. 8 (1886). *T. Stuhlmanni* Eichelb. in Verh. Nat. Ver. Hamb., ser. 3, xiv. 32 (1907).

Pl. 158.—*a.* sporangia; *b.* elater; *c.* spores (England); *d.* spore, reticulated on one side, spinulose on the other (United States).

The elaters vary in length in different gatherings; usually they are long and taper only towards the ends, sometimes they are short and somewhat fusiform; they are either simple or branched, but apparently never unite to form a *Hemitrichia*-like network. The warts on the spores may be scattered, and number either eight to ten in a line across the hemisphere, or are more crowded; in some specimens the spores are minutely reticulated on one side, and spinulose on the other. The white and rose-coloured plasmodia have not been observed growing together on the same piece of wood, but the sporangia produced from both appear to be identical in every respect; although shades of difference occur in various gatherings, the colour of the plasmodium cannot be inferred from the ripe fruits. The slender stalks filled with spore-like cells distinguish this species from *T. Botrytis*, its nearest ally. Sporangia sometimes occur that are almost or quite sessile, but they are usually accompanied by others having well formed stalks.

*Hab.* On dead wood. Common.—St. Catherines, Somerset (B.M. 387); Lyme Regis, Dorset (B.M. 1471); Boynton, Yorks (B.M. 1124); North Wales (B.M. 2917); Aberdeen (B.M. 2918); Ireland (B.M. 2919); France (K. 1059); Germany (B.M. 749); Denmark (B.M. 2920); Norway (B.M. 2921); Sweden (B.M. 1729); Switzerland

(B.M. 2922); Italy (B.M. 1951); Portugal (B.M. 2923); Ceylon (Peradeniya Herb.); Java (B.M. 2924); New Zealand (B.M. 2925); Japan (B.M. 2926); Vancouver B.C. (B.M. 2927); Maplehurst, Ontario (B.M. 2928); Washington State (B.M. 2929); Iowa (B.M. 836); Colorado (B.M. 2930); South Carolina (K. 1053).

11. *T. Botrytis* Pers. in Roemer, N. Mag. Bot., i. 89 (1794). Plasmodium purple-brown. Total height 1.5 to 5 mm. Sporangia stalked, pyriform or turbinate, simple or combined in clusters, 0.6 to 0.8 mm. diam., yellowish-olive, red-brown, purple, or nearly black, often marked with paler lines of dehiscence; sporangium-wall of two layers, the outer charged with granular matter and continued into the stalk, the inner membranous, enclosing the spores. Stalks cylindrical, often combined in clusters of three to eight, furrowed, red- or purple-brown, consisting within of a spongy tissue enclosing refuse matter. Capillitium of cylindrical or fusiform yellowish-brown elaters, 4 to 5  $\mu$  diam., sometimes branched, gradually tapering to long slender points which are smooth at the tips, marked with three to five flattened or prominent lax and often rugged spiral bands, with intervals of about 1  $\mu$ . Spores ochraceous-yellow, minutely spinulose, 9 to 11  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 216. *Stemonitis Botrytis* Pers. in Gmel. Syst. Nat., 1468 (1791). *Trichia serotina* Schrad. in Schrad. Journ. Bot., v. 67 (1799). *T. pyriformis* Fr. Syst. Myc., iii. 184 (1829) non Pers. *T. Lorinzeriana* Corda Icon., i. 23, f. 228 D (1837). *T. purpurascens* Nyll. in Saellsk. Faun. Fl. Fenn., iv. 126 (1859); Mass. Mon., 177. *T. fragilis* Rost. Mon., p. 246 (1875); Mass. l.c., 175. *T. Carlyleana* Mass. in Journ. R. Micr. Soc., 1889, 329; Mass. Mon., 174. *Sphaerocarpus fragilis* Sow. Engl. Fung., t. 279 (1803).

Var 1.—*lateritia* Lister: stalks clustered, red, 2 mm. or more long; elaters pale burnt-sienna colour, terminating in a more or less abruptly tapering point 20 to 40  $\mu$  long, the spirals continued almost to the extremity; spores orange.—*T. lateritia* Lév. in Ann. Sci. Nat., ser. 3, v. 167 (1846); Rost. Mon., p. 250. *T. Decaisneana* de Bary in Rost. Mon., l.c.; Mass. Mon., 185.

Var. 2.—*munda* Lister: elaters pale brown or yellowish-brown, marked with close and regular spiral bands, with long tapering points; spores yellow or brownish-yellow.—See Journ. Bot., xxxv. 216.

Var. 3.—*flavicomma* Lister Mycetozaa, 172 (1894): sporangia minute, solitary, purplish-brown with yellow lines of dehiscence; elaters and spores bright yellow.

Pl. 163.—*a.* sporangia (England); *b.* elater, var. *munda*; *c.* elater of typical form; *d.* spore; *e.* sporangia, var. *lateritia*; *f. g. h.* elaters of same; *i.* spore; *j. k.* sporangia and elater of var. *flavicomma*.

The various characters distinguishing the different forms of this abundant species blend freely into one another, but the colour of the capillitium and spores is generally associated with a form of the elaters of sufficient constancy to enable the specimens to be classed under the above varieties. Three varieties are given by Rostafinski, distinguished by the colour of the sporangia and of the capillitium and spores when seen in mass; but the colour of the sporangium is a character which varies so widely that it cannot be taken as marking constant types; specimens in the Strassburg Herbarium have sessile black sporangia associated with others of brown and bright nut-colour; a few have long free stalks, and others are clustered on a common stem. In a large cultivation from a single growth of plasmodium at Lyme Regis, the sporangia are either olive or rosy-purple marbled over with yellow lines of dehiscence, or almost uniformly black. The type of *T. lateritia* Lév., from Chili (K. 1761), has nearly black sporangia; other gatherings from England and the Continent, with similar characters of capillitium and spores described here under var. *lateritia*, have either black, rosy, or brown sporangia. The "simple" and "*botrytis*" forms are mingled in most large gatherings, but the "*botrytis*" form is most frequent in var. *lateritia*. The type of *T. Decaisneana* de Bary, from Paris, in the Strassburg Herbarium, is included under the latter variety; the elaters are remarkably long, suddenly narrowing to a point 10 to 15  $\mu$  in length, from a subterminal bulb; a similar bulb occurs in the middle of some of the elaters. The occurrence of bulbous swellings in the elaters is so frequent and at the same time so inconstant in many species of *Trichia* that it cannot be received as a specific character. *T. Carlyleana* Mass., from Carlisle, is the typical form with minutely spinulose spores perhaps more nearly smooth than usual. The type of *T. purpurascens* Nyl. from Finland, is the same form, and has dull purple sporangia; the spores average 10  $\mu$  diam., and are minutely spinulose. Sometimes in the typical form the walls are sprinkled with deposits of sulphur-yellow mealy or waxy deposits; it is possible that this appearance is found only after the sporangia have undergone some amount of weathering.

*Hab.* The typical form and var. *lateritia* occur on dead wood; var. *munda* occurs usually on dead leaves, but has been found also on dead wood; var. *flavicoma* occurs on dead leaves only, especially on those of holly.—Lyme Regis, Dorset (B.M. 1472); Leigh, Somerset (B.M. 399); Eltham, Kent (B.M. 355); Weybridge, Surrey (K. 1086); Carlisle (Herb. Massee); North Wales (B.M. 2931); Glamis, Scotland (B.M. 385); Ireland (B.M. 2932); Finland (K. 1090); Sweden (B.M. 2933); Switzerland (B.M. 2934); Portugal (B.M. 2935); New Zealand (B.M. 2936); Japan (B.M. 2017); Washington State (B.M. 2937); Philadelphia (B.M. 2938); var. *lateritia*—Failand, Somerset (B.M. 2939); Orton, Leicester (B.M. 391); Broseley, Salop (B.M. 2940); Paris (Strassb. Herb.); Germany (B.M. 759); Poland (Strassb. Herb.); Switzerland (B.M. 760); Italy (B.M. 758); Ceylon (B.M. 762); Australia (K. 1082); Tasmania (K. 1759); New Zealand (K. 1098); Japan (B.M. 2941); Philadelphia (B.M. 1888); Maine, U.S.A. (B.M. 1619); Chili (K. 1761); var. *munda*—Epping Forest, Essex (B.M. 2942); New Forest, Hants (B.M. 2943); Broseley, Salop (B.M. 2944); Chatsworth, Derby (B.M. 2945); Nottingham (B.M. 2946); near Dublin (B.M. 2947); Austria (B.M. 2948); Portugal (B.M. 2949); Glacier, British Columbia (B.M. 2950); Washington

State (B.M. 3192); Manchester, Mass. (Herb. Dr. Sturgis): var. *flavicomae*—Lyme Regis (B.M. 1475); Witley, Surrey (B.M. 2951); Leighton, Beds (B.M. 2952); Wardour Castle, Wilts (B.M. 2953); Portugal (B.M. 2954).

12. *T. subfusca* Rex in Proc. Acad. Nat. Sci. Phil., 1890, 192. Plasmodium? Sporangia stalked, gregarious, solitary or united in pairs, subglobose or pyriform, 0.5 to 0.9 mm. diam., dull brown, yellowish- or reddish-brown; sporangium-wall membranous with dark granular deposits. Stalk brown or purple-brown, stout and furrowed, separated from the cavity of the sporangium by the inner layer of the sporangium-wall. Capillitium consisting of bright yellow elaters, marked with three to four prominent spiral bands, ending in short slender often curved tips. Spores yellow, minutely spinulose, 11 to 13  $\mu$  diam.—Machr. N. Am. Slime-Moulds, 217. *T. Botrytis* var. *subfusca* Lister Mycetozoa, 172.

Pl. 163.—*l.* sporangium; *m.* elater; *n.* spore; (Adirondack Mountains, New York).

This species is closely allied to *T. Botrytis*, of which perhaps it is hardly more than a marked variety with the ends of the yellow elaters short, not long and tapering.

*Hab.* On dead wood.—Ireland (B.M. 2955); Norway (B.M. 2956); Ceylon (B.M. 2957); Washington State (B.M. 1944); Adirondack Mountains, New York (B.M. 1897).

Genus 39.—**OLIGONEMA** Rostafinski Mon., p. 291 (1875). Sporangia minute, densely clustered or heaped; capillitium usually scanty, of short or long threads, with spiral markings obscure or wanting; spores reticulated.

## KEY TO THE SPECIES OF *OLIGONEMA*.

Sporangia globose, heaped together; sporangium-wall smooth; spores irregularly reticulated. 1. *O. nitens*

Sporangia ovoid, crowded; sporangium-wall with minute granular thickenings; spores regularly reticulated.

2. *O. flavidum*

1. *O. nitens* Rost. l.c., f. 198. Plasmodium watery-white. Sporangia subglobose, sessile, heaped together for the most part in large clusters, 0.2 to 0.4 mm. diam., shining, yellow or olivaceous-yellow; sporangium-wall membranous, yellow, smooth except for scattered horseshoe-shaped thickenings enclosing a thinner membrane. Capillitium of usually short, cylindrical, simple, branched, or ring-shaped yellow elaters, 3 to 5  $\mu$  diam., with rounded or abruptly pointed ends, either smooth or marked with one to four irregular and indistinct spiral bands passing from the right above to the left below when the thread is viewed horizontally, occasionally provided with ring-shaped thickenings and scattered spines. Spores yellow,

11 to 16  $\mu$  diam., reticulated with broad and pitted bands, or with narrow bands forming an irregular net, border 0.5 to 1.5  $\mu$  wide.—Mass. Mon., 170; Macbr. N. Am. Slime-Moulds, 221. *Trichia nitens* Libert Pl. Crypt. Ard., Fasc. iii. no. 277 (1834) (*non* Pers.). *T. bavarica* de Thuemen Myc. Univ., no. 1497 (1879). *T. Kickxii* Rost. Mon., App. p. 40 (1876). *T. pusilla* Schroet. in Cohn Krypt. Fl. Schles., iii. pt. 1, 114 (1885). *Physarum Schweinitzii* Berk. in Grev., ii. 66 (1873). *Cornuvia nitens* Rost. Versuch, 15 (1873). *Oligonema bavaricum* Balf. & Ber., in Sacc. Syll., vii. 437 (1888). *O. minutulum* Mass. in Journ. R. Micr. Soc., 1889, 348; Mass. Mon., 171.

Pl. 164.—*d.* sporangia; *e.* elaters; *f.* spore; (Ardennes; Mme. Libert's type).

This species varies in the markings on the elaters and the reticulation of the spores; few gatherings are exactly similar, and great variety is often seen in a single sporangium; the length of the elaters in some specimens is only about 50  $\mu$ , while in others the average is from three to four times as long. *O. nitens* is allied to *Trichia affinis*, in which species similar variations in spores and elaters are sometimes found in sporangia which have been exposed to unusual conditions of development. A remarkable variety appeared in the Botanic Gardens at Leipsic (B.M. 2960, ex. Herb. Celakovsky) in which many of the elaters branch and anastomose while others remain free; the threads are expanded into irregular vesicles at the axils of the branches, and are marked with ring-shaped thickenings and about four faint spiral bands. *O. bavaricum* Balf. & Berl. is described as distinguished from the present species by the more distinct spirals on the elaters, but the spirals are quite as distinct in Libert's type; the spores of the Bavarian gathering vary in size from 12 to 16  $\mu$ , and the reticulation also varies so as to present from four to sixteen meshes on the surface of the hemisphere. The type specimens of *O. minutulum* Mass., from Algiers (B. 1739), and *Physarum Schweinitzii* Berk., from Bethlehem, U.S.A. (K. 1738), are typical *O. nitens*. The descriptions of *Trichia Kickxii* Rost. and *T. pusilla* Schroet. agree so perfectly with the character of *O. nitens* that they are here placed as synonyms of this species.

*Hab.* On dead wood.—"Hay-pit," Staffordshire (B.M. 1476); Cornwall (B.M. 2958); Scarborough (B.M. 2959); Belgium (B.M. 747); Germany (Strassb. Herb.); Bavaria (B.M. 746); Leipsic (B.M. 2960); Algiers (K. 1739); Bethlehem, South Carolina (K. 1738); Cambridge, Mass. (B.M. 2961); British Columbia (B.M. 2962).

2. *O. flavidum* Peck in Rep. N. York Mus., xxxi. 42 (1879). Plasmodium watery-white? Sporangia crowded or somewhat heaped, ovoid or subglobose, 0.3 to 0.6 mm. diam., shining, yellow; sporangium-wall membranous, translucent, yellow, marked with minute close-set thickenings arranged in wavy or fan-like lines, which give the effect of delicate stippling. Capillitium scanty or fairly abundant, of short or long, simple or branched threads, varying from 3 to 5  $\mu$  diam., often showing irregular swellings, without distinct spiral bands, but marked with close lines of minute warts that usually form irregular

spirals passing from the left above to the right below when the thread is viewed horizontally,—that is in the reverse direction to the spirals of *Trichia* elaters. Spores yellow, 12 to 13  $\mu$  diam., regularly reticulated with narrow bands, which give a border of 1  $\mu$ , and form a net showing three to five meshes across the hemisphere.—Mass. Mon., 171; Macbr. N. Am. Slime-Moulds, 220; Lister in Journ. Bot., xlii. 137; Torrend Fl. Myx., 119. *Perichaena flavida* Peck l.c., xxvi. 76 (1874). *O. breviflum* Peck l.c., xxxi. 42 (1879); Macbr. l.c., 221. *O. nitens* Lister Mycetozoa, 173, in part.

Pl. 165.—*a.* sporangia; *b.* elaters and spores with fragment of sporangium-wall; *c.* part of elater, and two spores; (Sussex).

This species is nearly allied to the preceding, but appears to be constantly distinguished by the granular thickenings of the sporangium-wall, the minutely warted capillitium and by the regular reticulation of the spores. Among the numerous gatherings made by Mr. Hugo Bilgram in Fairmount Park, Philadelphia, is one (B.M. 2966) having the capillitium threads long and repeatedly branched and anastomosing; the spore-net is closer than usual, showing about five meshes across the hemisphere. This gathering serves to prove how close is the connection between *O. flavidum* and *Calonema aureum*. The type of *O. breviflum* Peck appears to differ from that of *O. flavidum* only in having fewer and shorter elaters.

*Hab.* On dead wood.—Hencot, Salop? (B.M. 2963); Horsham, Sussex (B.M. 2964); Portugal (B.M. 2965); N. Germany (B.M. 3203); New York (B.M. slide); Philadelphia (B.M. 1478); Iowa (B.M. 1023); South Carolina (B.M. 964).

Genus 40.—**CALONEMA** Morgan Myx. Miami Valley, 33 (1893). Resembling *Oligonema*, except that the threads of the capillitium are combined to form a network.

1. **C. aureum** Morgan l.c. Plasmodium? Sporangia sessile, clustered, subglobose, 0.3 to 0.6 mm. diam., shining, yellow; sporangium-wall membranous, yellow, translucent, marked with delicate branched lines of thickening forming an irregular net resembling fan-tracery with thinner spots whence the lines of tracery radiate. Capillitium consisting of branching yellow threads, 3 to 5  $\mu$  diam., more or less united to form a network, and marked with raised lines, or rows of minute warts, arranged to form either an irregular reticulation or spirals like those on the elaters of *Oligonema flavidum*; ring-shaped thickenings and scattered spines usually present. Spores yellow, 13 to 15  $\mu$  diam., regularly reticulated with narrow raised bands, which give a border of 1 to 1.5  $\mu$  to the margin, and form a net showing five to six meshes across the hemisphere.—Macbr. N. Am. Slime-Moulds, 208. *Oligonema flavidum* var., Lister in Journ. Bot., xlii. 138.

Pl. 165.—*d.* sporangia; *e.* capillitium and fragment of sporangium-wall; *f.* capillitium and two spores; (Ohio).

This species has been found repeatedly, maintaining its distinctive characters, in various States of North America. It is closely allied to *Oligonema flavidum*, with which it is connected by intermediate forms, and of which it appears to be hardly more than a variety. Morgan's genus *Calonema* is here retained for convenience of classification.

*Hab.* On dead wood.—South Carolina (B.M. 954, 960); Ohio (B.M. 2967); Maryland (B.M. 2968); Minnesota (B.M. 2969).

Genus 41. — **HEMITRICHIA** Rostafinski Versuch, 14 (1873). Sporangia stalked or sessile; capillitium a more or less elastic network of branching threads, thickened with two to six spiral bands; spores minutely warted or reticulated. *HEMIARCYRIA* Rost. Mon., p. 261 (1875).

The original name which Rostafinski gave to this genus is here restored in accordance with the laws of botanical nomenclature, while at the same time it expresses more accurately the affinities of the group.

### KEY TO THE SPECIES OF *HEMITRICHIA*.

#### A. Spores nearly smooth or minutely warted :—

a. Capillitium red, spinose. 1. *H. Vesparium*

b. Capillitium yellow, yellow-brown or yellow-grey—

a. Sporangia usually stalked—

Stalk solid; sporangia orange; capillitium spinose, with distinct spiral markings. 2. *H. intorta*

Stalk solid; sporangia olive-yellow; capillitium smooth, spiral markings often faint.

3. *H. leiotricha*

Stalk solid or absent; sporangia minute, buff; capillitium smooth or spinose, spiral markings faint. 4. *H. minor*

Stalk hollow, filled with spore-like cells—

Cup papillose.

5. *H. clavata*

Cup smooth.

6. *H. leiocarpa*

β. Sporangia sessile—

Spirals of capillitium one to three, prominent; sporangium-wall translucent. 7. *H. abietina*

Spirals of capillitium three or more, indistinct; sporangium-wall thickened with granular deposits.

8. *H. Karstenii*

#### B. Spores reticulated :—

Capillitium threads spinose.

9. *H. Serpula*

Capillitium threads smooth.

10. *H. chrysospora*

1. *H. Vesparium* Macbr. N. Am. Slime-Moulds, 203 (1899). Plasmodium purple-red. Total height 1.3 to 2.5 mm. Sporangia clavate or sub-cylindrical, stalked or sessile, combined in clusters or crowded, 1 to 1.3 mm. high, 0.5 to 0.7 mm.



broad, glossy or shining, dark red, red-brown, or olive-black; sporangium-wall of two layers, the outer continued into the stalk, the inner enclosing the spores, orange-red. Stalks membranous, 0.2 to 1 mm. high, usually combined in clusters of from six to twelve, furrowed and rugose, red, not enclosing spore-like cells. Capillitium red or orange-red in mass, consisting of twisting, sparingly branched, orange-red threads 5 to 6  $\mu$  diam., with few pointed free ends, marked with three to five regular spiral bands, and studded with numerous scattered spines 2 to 5  $\mu$  long, rarely nearly smooth. Spores pale orange-red, warted, 10 to 11  $\mu$  diam.—*Lycoperdon Vesparium* Batsch Elench. Fung., 253, fig. 172 (1786). *Stemonitis cinnabarina* Roth Fl. Germ., 547 (1788)? *Trichia pyriformis* Hoffm. Veg. Crypt., ii. 1, t. 1, fig. 1 (1790). *T. rubiformis* Pers. in Roemer N. Mag. Bot., i. 89 (1794); Fr. Syst. Myc., iii. 183. *T. chabybea* Chev. Fl. Paris, i. 323 (1826). *T. Neesiana* Corda Icon., i. 23 (1837). *T. Ayresii* Berk. and Br. in Ann. Mag. Nat. Hist., ser. 2. v. 367 (1850). *Craterium floriforme* Schw. in Trans. Amer. Phil. Soc., n.s. iv. 258 (1832)? *C. porphyrium* Schw. l.c.? *Hemiarcyria rubiformis* Rost. Mon., p. 262 (1875). *Arcyria rubiformis* Mass. Mon., 158 (1892). *Hemitrichia rubiformis* Lister Mycetoza, 175 (1894).

Pl. 166.—*a.* cluster of sporangia; *b.* capillitium and spores with fragment of sporangium-wall; *c.* capillitium and spore: (England).

Sporangia are occasionally found with a few free elaters pointed at each end in addition to the continuous network of threads of the usual type.

*Hab.* On dead wood: not unfrequent.—Orton, Leicestershire (B.M. 335); Rudloe, Wilts (B.M. 340); Batheaston, Somerset (B.M. 341); Lyme Regis, Dorset (B.M. 2970); Wanstead, Essex (B.M. 1481); Hampstead, London (B.M. 1123); Sutton Coldfield, Warwick (B.M. 1480); Alnwick, Northumberland (B.M. 2971); France (K. 123); Germany (B.M. 791); Sweden (B.M. 2972); Finland (B.M. 788); Italy (B.M. 789); Switzerland (B.M. 2973); Austria (B.M. 1835); Portugal (B.M. 2974); Madagascar (B.M. 2976); Ceylon (B.M. 2975); Java (Herb. Massee); Kansas (B.M. 2977); Texas (B.M. 956); Iowa (B.M. 830); Philadelphia (B.M. 1808); Maine (B.M. 1624); South Carolina (B.M. 761); Antigua (B.M. 1682).

2. *H. intorta* Lister Mycetoza, 176 (1894). Plasmodium watery-white. Total height 1 to 1.5 mm. Sporangia stalked, gregarious or scattered, turbinate, 0.3 to 0.7 mm. diam., shining, orange-yellow; sporangium-wall membranous above, thickened with granular deposits towards the base, papillose on the inner side. Stalk thickened above and below, with two to four broad longitudinal furrows, 0.5 to 0.7 mm. long, 0.15 mm. thick in the middle, glossy, purplish-brown, solid, not filled with spore-like cells. Capillitium a twisted tangle of sparingly branched orange-yellow threads, 4  $\mu$  diam.,

marked with four to five closely set spiral bands sometimes connected with longitudinal striae, densely spinulose. Spores yellow, minutely warted, 9 to 10  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 205. *Hemiarcyria intorta* Lister in Journ. Bot., xxix. 268, tab. 312, fig. 3 (1891). *H. longifila* Rex in Proc. Acad. Nat. Sci. Phil., 1891, 396.

Pl. 172.—*a.* sporangia; *b.* capillitium and spores; (England).

This species appeared in considerable abundance on an old elm log, near Hitchin, Herts, in March, 1889, and January, 1890. It was also gathered near Birmingham by Mr. Camm in October, 1889, and was described in the *Journal of Botany*, l.c. A few months later it was independently recorded by Dr. Rex l.c., under the name of *H. longifila*. Specimens received from Dr. Rex from Fairmount Park, Philadelphia, and Prof. Macbride, from Iowa, are essentially identical with the English gatherings.

*Hab.* On dead wood.—Hitchin, Herts (B.M. 1483); Philadelphia (B.M. slide); Iowa (B.M. slide).

3. *H. leiotricha* Lister. Plasmodium watery-white. Sporangia stalked, rarely sessile, scattered, subglobose, 0.5 to 0.9 mm. diam., shining, dull yellow or olivaceous; sporangium-wall usually of two layers, the outer composed of scattered deposits of dark brown refuse matter, the inner translucent, marked with scattered ring-shaped or crescentic thickenings. Stalk dark brown or black, stout, 0.1 to 0.3 mm. high. Capillitium a twisted tangle of sparingly branched smooth yellow threads, with few or many rounded or pointed free ends, marked with 3 to 6 often faint spiral bands. Spores yellow or olivaceous, minutely warted, 9 to 13  $\mu$  diam.—*H. intorta* var. *leiotricha* Lister Mycetozoa, 176; R.E. Fries in Arkiv. Bot., iv. no. 7, 5; Petch in Ann. Perad., iv. 363.

Pl. 172.—*c.* sporangia; *d.* capillitium and spores; (England).

In the former edition of the present work this species was described as a variety of *H. intorta*, to which it is undoubtedly nearly allied. The constancy of the form, with its olivaceous sporangia and smooth capillitium, has now been proved by gatherings from six English counties, from Norway, Sweden, and Germany, and also from Ceylon. The capillitium may vary considerably in the sporangia of even a single group, consisting either of long free elaters, or of the typical *Hemitrichia* network. In a cold weather development obtained by Mr. W. B. Allen on bramble stems near Broseley, Salop (B.M. 2982), some of the nearly sessile sporangia have normal capillitium, while in others it consists of both short and long, simple or branching threads, without spiral markings, but provided with many broad ring-like thickenings. In a specimen gathered by Mr. Petch on the leaf of a Talipot palm (*Corypha*) in Ceylon (B.M. 2985), the sporangia were rose pink when immature, and are nearly or quite sessile; the capillitium differs from typical *H. intorta* in being marked with five to six close spiral bands; the sporangium-wall has scanty deposits of refuse matter.

*Hab.* On dead leaves, bramble stems, etc.—Wanstead, Essex, (B.M. 1945); Devon (B.M. 2978); Dorset (B.M. 2979); Witley, Surrey (B.M. 2980); Leighton, Beds (B.M. 2981); Broseley, Salop (B.M. 2982); Sweden (B.M. 2983); North Germany (B.M. 2984); Ceylon (B.M. 2985).

**4. *H. minor*** G. Lister in Journ. Bot., xlix. 62 (1911). Plasmodium? Sporangia stalked or sessile, scattered or united in pairs, subglobose, 0.2 to 0.4 mm. diam., glossy, pale yellowish-buff; sporangium-wall membranous, pale yellow, minutely papillose or marked with faint curved lines of thickening, and having scanty superficial deposits of refuse matter. Stalk black, cylindrical, enclosing dark refuse matter, 0.1 to 0.2 mm. high. Capillitium a loose network of flaccid yellowish threads 3 to 4  $\mu$  diam., with few or many free ends, marked with three or four faint spiral bands, either almost smooth or rather closely studded with slender spines 1 to 4  $\mu$  long, often showing ovoid vesicular expansions. Spores pale yellow, closely and minutely warted, 9 to 10  $\mu$  diam.

Pl. 187.—*d.* sporangia; *e.* capillitium; *f.* capillitium and spore with fragment of sporangium-wall; (Japan).

This minute and inconspicuous species has been gathered in small quantities on three occasions on the bark of fallen branches by Mr. K. Minakata, in the province of Kii, Japan. It somewhat resembles *Perichaena vermicularis* Rost., but differs in the capillitium being marked with spiral bands. The capillitium threads vary in roughness in the different gatherings; in one specimen they are almost smooth, in another they are closely marked with warts and short spines, while in a third they are studded with both short and long spines. *H. minor* is perhaps most nearly allied to *H. Karstenii*, as suggested by Mr. Minakata, but we require more material to establish its relations with certainty.

*Hab.* On dead bark amongst Hepatics.—Tanabe, Kii, Japan (B.M. 2986).

**5. *H. clavata*** Rost. Versuch, 14 (1873). Plasmodium watery-white. Total height 1 to 3 mm. Sporangia stalked, gregarious, clavate or turbinate, rarely globose, 0.7 to 1.5 mm. high, shining, ochraceous or olivaceous-yellow; sporangium-wall membranous, minutely papillose on the inner side, rarely reticulated, yellow, evanescent above, persistent below to form a more or less definite cup. Stalk cylindrical, 0.1 to 1.5 mm. long, furrowed or nearly even, olive, red-brown, or nearly black, hollow and filled with spore-like cells. Capillitium a network of yellowish-olive branched threads 5 to 6  $\mu$  diam., with or without rounded free ends, marked with five to six well-defined close or lax spiral bands 1  $\mu$  wide, usually velvety in profile, sometimes spinose in imperfect developments. Spores ochraceous, minutely warted, 8 to

10  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 206. *Trichia clavata* Pers. in Roemer N. Mag. Bot., i. 90 (1794). *T. citrina* Schum. Enum. Pl. Saell., ii. 209 (1803) ? *T. obtusa* Wigand in Pringsh. Jahrb. Wissensch. Bot., iii. 30, t. 2, f. 4 (1863). *Arcyria decipiens* Berk. in Ann. Mag. Nat. Hist., ser. 1, ix. 447 (1842). *A. clavata* Mass. Mon., 165 (1892). *A. calyculata* Mass. l.c., 162. *A. stipitata* Mass. l.c., 163. *A. leocarpoides* Mass. l.c., 167. *Hemiarcyria clavata* Rost. Mon., p. 264 (1875). *H. calyculata* Speg. in Ann. Soc. Cient. Argent., x. 152 (1880). *H. stipitata* Mass. in Journ. R. Micr. Soc., 1889, 354. *H. ablata* Morgan Myx. Miami Valley, 30 (1893). *H. funalis* Morg. l.c., 32. *H. plumosa* Morg. l.c., 29. *Cornuvia leocarpoides* Speg. l.c., xii. 256 (1881). *Hemitrichia stipitata* Macbr. N. Am. Slime-Moulds, 207 (1899). *H. montana* Morgan ex Macbr. l.c., 208.

Pl. 167.—*a.* sporangia; *b.* capillitium; *c.* spores (England); *d.* sporangia developed in cold weather (Philadelphia); *e.* capillitium of same showing spines, appearing among threads of the usual form, also fragment of sporangium-wall; *f.* sporangium with expanded capillitium.

This abundant and widely distributed species is, on the whole, remarkably constant in its main characters. At the same time, as Dr. Rex has noted, it is subject to some variation depending on climate, the season of the year, and on altitude. He writes (Bot. Gaz., xv. 315): "*Hemiarcyria clavata* developed in the hot days of July and August will erect quickly into scattered, globose, long-stiped sporangia which rupture immediately as they dry, leaving scarcely a vestige of a receptacle, while the same species late in October will develop closely aggregated, obovate, almost clavate sporangia, nearly sessile or with quite short stipes, which rupture slowly several days after maturity, leaving a very deep funnel-shaped receptacle." The presence of free ends to the capillitium threads is not an unusual character, although in the most perfect developments they are usually absent. A gathering made by Dr. Sturgis in the Adirondack Mountains, New York, in September, 1901, shows many free ends amongst the tangle of capillitium, and has also a number of short free elaters. The type of *H. montana* Morgan from the San Bernadino Mountains, California, appears to be an irregular form of the present species: the sporangia are shortly stalked or sessile, the capillitium is much branched and has many free ends, and although in some parts the spirals are regular, in others they are loose and rugged; the sporangium-wall is not papillose as in normal growths, but is marked with a delicate network resembling fan-tracery; similar markings associated with papillae appear in a specimen from Chili gathered by Prof. Thaxter (B.M. slide). The type of *Arcyria stipitata* Mass. from Java, is a perfectly formed long-stalked specimen of *H. clavata*, with no free ends to the capillitium. The type of *Arcyria decipiens* Berk., collected by Charles Darwin at Rio Janeiro (K. 1766) is also a typical form of the present species.

*Hab.* On dead wood.—Batheaston, Somerset (B.M. 354); Dudley, Stafford (B.M. 1484); Lyme Regis, Dorset (B.M. slide); Ivinghoe, Bucks (B.M. 1485); Bushey, Herts (B.M. 2987); France (K. 134); Germany (B.M. 792); Sweden (B.M. 2988); Poland (Strassb. Herb.);

Switzerland (Zürich Herb.); Portugal (B.M. 2989); Cameroons, West Africa (B.M. 2990); Natal (K. 148); Ceylon (K. 1765); Java (K. 1768); Borneo (B.M. slide); Bonin Islands (K. 138); Japan (B.M. 2991); Montreal (B.M. 2994); Philadelphia (B.M. 1486); Washington State (B.M. 2992); Iowa (B.M. 831); California (B.M. slide); Colorado (B.M. 2993); South Carolina (B.M. 796); Cuba (K. 1765A); Antigua (B.M. 1683); Venezuela (K. 1767); Brazil (B.M. 1773); Paraguay (Paris Herb.); Chili (Paris Herb.).

**6. *H. leiocarpa*** Lister. Plasmodium? Total height 1.5 mm. Sporangia scattered, stalked, obovoid, rarely subglobose, pale grey or ochraceous-grey, 0.7 mm. diam.; sporangium-wall evanescent above, persistent below as a cup, membranous, smooth, colourless, longitudinally plicate, minutely wrinkled transversely. Stalk 0.7 mm. long, 0.05 mm. thick, furrowed, ochraceous-grey, containing spore-like cells. Capillitium a network of frequently branching, pale grey threads, 2 to 5  $\mu$  thick, marked with three to five often prominent spiral bands, sometimes smooth, but in many parts studded with numerous spines about 2  $\mu$  long; free ends subclavate, usually spinulose. Spores smooth, pale grey in mass, 6 to 8  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 205. *Hemiarcyria leiocarpa* Cooke in Ann. Lyc. Nat. Hist. N. York, xi. 405 (1877), & Myx. Brit., 88, figs. 252, 255. *H. Varneyi* Rex in Proc. Acad. Nat. Sci. Phil., 1891, 396. *Lachnobolus Rostafinskii* Racib. in Rozpr. Mat.-Przyr. Ak. Krak., xii. 80 (1884).

Pl. 168.—*a.* sporangia; *b.* capillitium and spore with fragment of sporangium wall; (Potts Point, Harpsell, Maine, U.S.A.)

This species is perhaps hardly more than a variety of the preceding, from which it differs in the pale colour, in the smooth colourless sporangium-wall, the smoother and rather smaller spores, and in the spinose tracts of the capillitium; the last character is rarely met with in *H. clavata*. The type of *H. Varneyi* Rex from Kansas has a more elongated sporangium and a shorter stalk; but, in comparing the specimen kindly furnished by Dr. Rex with the type of *H. leiocarpa* from Maine, the other characters appear to be identical. Through the courtesy of Dr. Celakovsky we have been able to examine part of the type of *Lachnobolus Rostafinskii* Racib. from Cracow; it appears to agree in all respects with the present species.

*Hab.* On dead wood.—Maine (B.M. slide); Kansas (B.M. slide).

**7. *H. abietina*** Lister. Plasmodium rose-red. Sporangia crowded or gregarious, shortly stalked or sessile, subglobose or turbinate, 0.3 to 0.7 mm., opaque or shining, yellow, ochraceous, or apricot-coloured; sporangium-wall membranous, yellow, almost smooth, usually evanescent above and forming a persistent cup below. Stalks slender, ochraceous, 0.1 to 0.3 mm. long, filled with spore-like cells. Capillitium a tangle of flaccid, sparingly branched, ochraceous-yellow

threads, 3 to 5  $\mu$  diam., marked with one to three prominent bands forming an irregular loose spiral, with few rounded or bulbous free ends. Spores yellow, minutely warted, 9 to 12  $\mu$  diam.—*Trichia abietina* Wigand in Pringsh. Jahrb. Bot., iii. 33, t. ii, fig. 11 (1863). *T. nana* Mass. in Journ. R. Micr. Soc., 1889, 336; Mass. Mon., 181. *Hemiarcyria Wigandii* Rost. Mon., p. 267 (1875). *Arcyria Wigandii* Mass. l.c., 163 (1892). *Hemitrichia ovata* Macbr. N. Am. Slime-Moulds, 202 (1899).

Pl. 168.—*c.* sporangia; *d.* capillitium and spore (Germany); *e.* sporangia (United States).

This species somewhat resembles the occasional *Hemitrichia* forms of *Trichia varia*, but is distinguished by the stalks when present being filled with spore-like cells, by the often well defined cup-like base of the sporangium-wall, and by the flaccid capillitium marked with slender spiral bands that are not more prominent on one side of the thread. The type of *Trichia nana* Mass. from Westbrook, Maine (K. 1164) is a sessile form of *H. abietina*. Rostafinski refers to having seen a specimen of this species in Persoon's herbarium named *Trichia ovata*, in consequence of which Prof. Macbride, in view of adopting the earliest specific name, has called the present species *Hemitrichia ovata*; Persoon's description of *T. ovata*, however, applies better to *T. javoginea*, and Rostafinski was probably right in including *Trichia ovata* under the latter species.

*Hab.* On dead wood of fir, beech, etc.—Uplyme, Devon (B.M. 2995); Swarraton, Hants (B.M. 2996); Holstein (B.M. 2997); Norway (B.M. 1487); Portugal (B.M. 2998); Cambridge, Mass (B.M. 1488); Maine, U.S.A. (K. 1164); Colorado (B.M. 2274).

8. **H. Karstenii** Lister Mycetoza, 178 (1894). Plasmodium watery-white. Sporangia sessile, scattered, subglobose or forming elongated curved plasmodiocarps, 0.25 to 0.5 mm broad, pale yellowish-brown, red- or purplish-brown; sporangium-wall of two layers, membranous or cartilaginous, the outer layer thickened with deposits of granular matter. Capillitium a loose network of branching yellowish or reddish-brown threads, 3 to 5  $\mu$  diam., marked with three to five more or less distinct spiral bands, rarely smooth, often with scattered ring-shaped thickenings and irregular expansions; free ends pointed or blunt. Spores yellow, minutely warted, 9 to 15  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 202; Torrend Fl. Myx., 105. *Hemiarcyria Karstenii* Rost. Mon., App. p. 41 (1876). *H. paradoxa* Mass. in Journ. R. Micr. Soc., 1889, 356. *H. obscura* Rex in Proc. Acad. Nat. Sci. Phil., 1891, 395. *Arcyria Karsteni* Mass., 168 (1892). *A. paradoxa* Mass. l.c., 160. *Terichaena cornuoides* Cel. fil. Myx. Böhm., 26 Pl. i, figs. 6, 7 (1893).

Pl. 171.—*a.* plasmodiocarp; *b.* capillitium and spores with fragment of sporangium-wall; *c.* capillitium; *d.* spore.

*H. Karstenii* appears to be a *Hemitrichia* form of *Trichia contorta*, a species which it resembles in every respect, except that the capillitium

threads are combined instead of forming free elaters; it presents nearly the same variety in the shape and colour of the sporangia, and in the markings and colour of the capillitium. Rostafinski's type from Ceylon (K. 1773) has pale yellow-brown sporangia, and rugged capillitium with faint spirals and many large rounded expansions; the spores are yellow, minutely warted, and measure 10 to 11  $\mu$  diam. Specimens from near Dudley, found by Mr. Camm, have both globose and bolster-shaped purple-brown sporangia and orange-brown capillitium, strongly contrasting with the yellow spores. The type of *Arcyria paradoxa* Mass., from Weybridge (K. 132), closely resembles the Ceylon gathering of *H. Karstenii*, only differing in the more regular, less branched capillitium, with fewer expansions; it is therefore included under the present species. The type of *Hemiarcyria obscura* Rex, from Montana, U.S.A. (B.M. slide), shows a dull yellowish-red capillitium; the threads are 2.5 to 3  $\mu$  thick, and are marked with close faint spirals; the spores are similar to those of the type of *H. Karstenii* at Kew, and there appears to be no specific character by which to separate *H. obscura* from this species. The type of *Perichaena cornuvioides* Cel. fil. from Bohemia appears to be an abnormal form of *H. Karstenii*, in which the capillitium shows no trace of spirals, and is marked with many small bladder-like or cup-shaped expansions; a somewhat similar specimen has been gathered near Birmingham, but in this, part of the capillitium is marked also with distinct spiral bands. Such growths closely resemble forms of *Perichaena corticalis*.

*Hab.* On dead wood.—Dudley, Stafford (B.M. 1489); Weybridge, Surrey (K. 132); Devon (B.M. 2999); Yorks (B.M. 3002); Aberdeen (B.M. 3000); Ireland (B.M. 3001); Sweden (B.M. 3003); Bohemia (B.M. 3004); Ceylon (K. 1773); Washington State (B.M. 3005); Colorado (B.M. 3006); Montana (B.M. slide).

9. *H. Serpula* Rost. Versuch, 14 (1873). Plasmodium yellow (*fide* Macbride). Sporangia forming elongated winding branched plasmodiocarps, 0.4 to 0.6 mm. wide, usually forming a close net, golden-yellow or brownish-yellow, often seated on a red-brown hypothallus; sporangium-wall of two layers, the outer membranous or cartilaginous, yellow, or brownish-yellow from deposits of refuse-matter, the inner membranous delicately reticulated with a network resembling fan-tracery. Capillitium an elastic tangle of twisting, sparingly branched, yellow threads, 5 to 6  $\mu$  diam., marked with three to four rarely five to six well-defined regular spiral bands, spinose or smooth; longitudinal striae often distinct; free ends pointed. Spores yellow, reticulated with narrow bands forming a net with from nine to twelve meshes to the hemisphere, 10 to 12  $\mu$  diam.; border 0.5 to 1  $\mu$  wide.—Macbr. N. Am. Slime-Moulds, 201; Petch in Ann. Perad., iv. 364. *Mucor Serpula* Scop. Fl. Carn., ed. 2, ii. 493 (1772). *Lycoperdon lumbricale* Batsch Elench. Fung., Cont. i. 259. t. 30, fig. 174 (1786). *Trichia spongioides* Vill. Pl. Dauph., 1061 (1789). *T. Serpula* Pers. in Roemer N. Mag. Bot., i.

90 (1794). *T. reticulata* Pers. l.c. *T. venosa* Sehum. Enum. Pl. Sacl., ii. 207 (1803). *Hemiarcyria Serpula* Rost. Mon., 266 (1875). *Arcyria Serpula* Mass. Mon., 164 (1892).

Pl. 170.—*a.* plasmodiocarp; *b.* spore and spinose capillitium with fragment of double sporangium-wall (Botanic Gardens, Glasgow); *c.* spore and smooth capillitium (Ceylon).

This handsome species is widely distributed, and appears to be especially abundant in U.S. America and in the tropics. Mr. Petch writes that it is common in Ceylon, where "the netted plasmodiocarps sometimes extend over an area 4 or 5 cm. long and 2 or 3 cm. broad." A gathering made by him at Hakgala differs from the usual form in the smooth capillitium being marked with five to six close spiral bands, and in the spores being closely reticulated with shallow bands and showing about eighteen meshes to the hemisphere. Where the conditions of development have not been entirely favourable it is not unusual to find the capillitium to consist in part of short free elaters.

*Hab.* On dead wood.—In hothouse, Glasgow (Edinburgh Herb.); Fontainebleau, France (B.M. 3007); Germany (Strassb. Herb.); Poland (Strassb. Herb.); Switzerland (B.M. 3008); Bombay (B.M. 797); Ceylon (B.M. 802); Java (B.M. 3009); New Zealand (K. 131); Japan (B.M. 2020); Kansas (B.M. 3010); Iowa (B.M. 832); Philadelphia (B.M. 1901); New Hants (B.M. 3011); Antigua (B.M. 1684); Dominica (B.M. 1754).

10. *H. chrysospora* Lister Mycetoza, 180 (1894). Plasmodium? Sporangia sessile, crowded or scattered, subglobose, 0.5 to 1 mm. diam., or forming bolster-shaped plasmodiocarps, glossy, bright yellow; sporangium-wall membranous, with minute thickenings forming a broken reticulation. Capillitium a tangle or network of branching yellow threads, 4 to 5  $\mu$  diam., marked with four to five narrow bands arranged in a close, regular spiral, and connected by longitudinal striae; the threads with many shortly pointed free ends, often attached to various parts of the sporangium-wall. Spores yellow, reticulated with narrow, sharply defined bands, forming a regular net with six to nine meshes to the hemisphere, 14 to 18  $\mu$  diam.; border 1.5 to 2  $\mu$  broad.—*Hemiarcyria chrysospora* Lister in Grev., xv. 126 (1887); Mass. in Journ. R. Micr. Soc., 1889, 357. *Arcyria chrysospora* Mass. Mon., 164.

Pl. 169.—*a.* sporangia; *b.* capillitium and spores with fragment of sporangium-wall; *c.* capillitium and spore; (England).

This species was first found on fallen twigs and moss in a larch plantation near Lyme Regis, November, 1886. It has been found twice since, also in larch plantations, in Dorset and Devon; in both these gatherings the capillitium consists in part at least of very long free elaters. *H. chrysospora* appears to be closely allied to the sessile form of *Trichia verrucosa*.

*Hab.* On dead wood, etc.—Beaminster, Dorset (B.M. 3013); Charton, Devon (B.M. 3012).



The type of *Hemiarcyria pusilla* Speg. (in Ann. Soc. Cient. Argent., xii. 257 (1881)), from the Argentine Republic, is not met with in the quoted collections; it is described as being an exceedingly minute species, with nearly sessile, gregarious, rose-coloured and elliptical sporangia, 0.4 to 0.5 mm. high, 0.15 to 0.25 mm. diam.; capillitium forming a rather dense network of threads, 3 to 4  $\mu$  thick, marked with three or four spiral bands and furnished with minute spinules; spores smooth, 7 to 9  $\mu$  diam. The species occurred on bark, and does not appear to have been found more than once.

Genus 42.—**CORNUVIA** Rostafinski Versuch, 15 (1873). Sporangia sessile; capillitium a network of threads with thickenings in the form of simple rings; spores reticulated.

1. **C. Serpula** Rost. Versuch, 15 (1873). Plasmodium creamy-white. Sporangia sessile, subglobose, about 0.3 mm. diam. or forming curved, branched or net-like plasmodiocarps, shining, golden-yellow; sporangium-wall membranous, delicate, smooth, pale yellow. Capillitium a network of freely branching yellow threads, 3 to 5  $\mu$  diam., marked with well-defined prominent ring-shaped thickenings, arranged at intervals of about 2  $\mu$  or irregularly scattered; junctions of the branches without thickenings. Spores yellow, reticulated with narrow bands forming a net with from eight to twelve meshes to the hemisphere, 10 to 12  $\mu$  diam.; border 0.5 to 1  $\mu$  broad.—Rost. Mon., p. 289; Coon in Journ. R. Micr. Soc., 1907, 142, tt. x. xi. *Arcyria Serpula* Wigand in Pringsh. Jahrb. Bot., iii. 44 (1863). *Ophiotheca Serpula* Mass. Mon., 135.

Pl. 170.—*d.* sporangia; *e.* capillitium and spores with fragment of sporangium-wall; (Germany).

This minute species frequents tan heaps. The first British gathering was made in the spring of 1906 by Mr. J. M. Coon who found the shining mature sporangia in abundance on bark in a tanyard at Gram-pound near St. Austell, Cornwall; he also observed the young sporangia developing from cream-white plasmodium.

*Hab.* On tanning bark.—Cornwall (B.M. 2029); Germany (B.M. 784).

## Order II.—ARCYRIACEAE.

Sporangia simple, stalked or sessile; capillitium a network of tubular threads branching at wide angles, and thickened with spines, warts, cog-like prominences or half rings (rings in *Arcyria annulifera*), usually abundant (sometimes scanty and of free threads in *Perichaena corticalis*).

## KEY TO THE GENERA OF ARCYRIACEAE.

### A. Capillitium elastic :—

Sporangia stalked; sporangium-wall evanescent above, persistent as a cup below. (43) ARCYRIA.

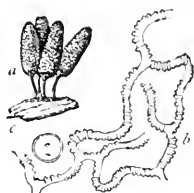


Fig. 50.

Fig. 50.—*Arcyria denudata* Sheldon.

- a. Group of sporangia. Twice natural size.  
 b. Capillitium. Magnified 250 times.  
 c. Spore. Magnified 560 times.

B. Capillitium not elastic :—

Sporangia sessile, heaped; sporangium-wall single, persistent, papillose, not thickened with angular granules.

(44) LACHNOBOLUS.

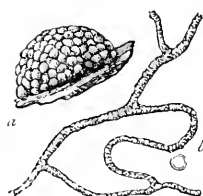


Fig. 51.

Fig. 51.—*Lachnobolus congestus* Lister.

- a. Cluster of sporangia. Twice natural size.  
 b. Capillitium and spore. Magnified 300 times.

Sporangia sessile or stalked; sporangium-wall usually double, at least at the base, and the outer layer thickened with dark angular granules.

(45) PERICHAENA.

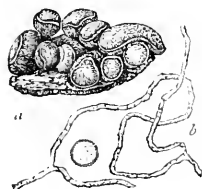


Fig. 52.

Fig. 52.—*Perichaena corticalis* Rost.

- a. Group of sporangia. Magnified 7 times.  
 b. Capillitium and spore. Magnified 280 times.

Genus 43.—**ARCYRIA** Wiggers Fl. Holsat., 109 (1780). Sporangia stalked! (sometimes sessile in *A. occidentalis*); sporangium-wall evanescent above, persistent below as a membranous cup; stalk filled with spore-like cells; capillitium a more or less elastic network with thickenings in the form of half-rings,\* cog-like prominences or spines, or marked with a broken reticulation, sometimes with three to five faint spiral lines in addition.

This genus is allied to *Hemitrichia* by those species in which the capillitium is marked with faint spiral bands; but the spirals never constitute the most conspicuous markings of the threads as in *Hemitrichia*.

\* The thickenings are in the form of minute rings in *A. annulifera*.

# KEY TO THE GENERA OF *ARCYRIA*.

- A. Spores 9 to 11  $\mu$  diam. ; sporangia orange-red or buff :—  
 Sporangia ovoid ; wall reticulated. 1. *A. ferruginea*  
 Sporangia clavate ; wall papillose. 2. *A. versicolor*
- B. Spores 6 to 8  $\mu$  diam. :—
- A. Cup entire—
- a. Capillitium attached to the cup—
- Sporangia clavate, grey or yellowish ; capillitium closely spinulose or warted. 3. *A. cinerea*  
 Sporangia globose, yellow ; capillitium with spines arranged in an open spiral. 4. *A. pomiformis*  
 Sporangia globose, whitish, on slender stalks ; capillitium closely spinulose or warted, the warts usually arranged in more or less spiral lines. 5. *A. globosa*  
 Sporangia globose, ochraceous ; capillitium very slender, marked with complete rings. 6. *A. annulifera*  
 Sporangia red, ovoid or subcylindrical ; capillitium marked with cogs and half-rings. 7. *A. denudata*  
 Sporangia rose-coloured, cylindrical or ovoid, small ; capillitium threads slender, marked with transverse bands and minute spines. 8. *A. insignis*  
 Sporangia glaucous ; capillitium marked with transverse bands and spines. 9. *A. glauca*
- b. Capillitium almost or quite free from the cup—
- a. Network of mature capillitium expanding, not drooping—
- Capillitium marked with cogs and spines only. 10. *A. incarnata*  
 Capillitium marked with cogs, spines, and three to four indistinct spiral bands in addition. 11. *A. stipitata*
- $\beta$ . Network of mature capillitium becoming much elongated, drooping—
- Sporangia buff ; wall evanescent above. 12. *A. nutans*  
 Sporangia red ; wall persistent above in a few shield-like fragments. 13. *A. Oerstedtii*
- B. Cup at length dividing nearly to the base in rounded lobes. 14. *A. occidentalis*

1. *A. ferruginea* Sauter in Flora, xxiv. 316 (1841). Plasmodium rose-red or cream-coloured. Total height 1 to 2 mm. Sporangia stalked, crowded, ovoid, 0·7 to 1·3 mm. high, 0·5 to 1 mm. broad, orange-red or red, more rarely ochraceous or yellow; cup of sporangium even, shining, funnel-shaped, or at length nearly flat, marked with round-meshed reticulation on the inner side. Stalk cylindrical, 0·3 to 0·8 mm. long, 0·05 to 0·15 mm. thick, red, rarely white, arising from a well-developed membranous hypothallus, filled with spore-like cells. Capillitium an elastic network of freely branching reddish-yellow or yellow threads, 5 to 6  $\mu$  diam., diminishing to 2 to 3  $\mu$  diam. towards the base, triangular or oval in section, usually thicker on one side and marked with transverse bars or reticulations arranged in a lax spiral, on the other two sides marked with a broken reticulation or with warts, often spinulose throughout; a few sparingly branched, more slender and smoother threads penetrate the tube of the stalk, but are not attached to the cup; free ends with rounded or pointed tips are not unfrequent. Spores pale red or ochraceous, faintly and closely warted, 8 to 11  $\mu$  diam.—Rost. Mon., p. 279; Mass. Mon., 144; Macbr. N. Am. Slime-Moulds, 194; Petch in Ann. Perad., iv. 365. *A. dictyonema* Rost. l.c.; Mass. l.c., 154. *A. intricata* Rost. l.c., App. p. 37 (1876). *A. cinnamomea* Hazsl. in Oester. Bot. Zeitschr., xxvii. 84 (1877). *A. bonariensis* Speg. in Ann. Soc. Cient. Argent., x. 151 (1880)? *A. macrospora* Peck in Rep. N. York State Mus., xxxiv. 43 (1881). *A. inermis* Racib. in Rozpr. Mat. Przyr. Ak. Krak., xii. 82 (1884). *A. decipiens* Racib. l.c., 84? *A. aurantiaca* Raunk. in Bot. Tidssk., 1888, 61, t. 3, figs. 4, 9 to 11. *A. Raciborskii* Berl. in Sacc. Syll., vii. 430 (1888)? *A. cornuroides* Racib. in Hedw., xxviii. 123 (1889)? *A. clavata* Cel. fil. Myx. Böhm., 29 (1893). *Trichia polymorpha* Sow. Engl. Fung., t. 180 (1799) (*nomen*).

Var. *Heterotrichia* Torrend Fl. Myx., 98: capillitium a dense network with many pointed free ends, threads closely reticulated and spinulose all over, 5 to 8  $\mu$  diam.—*Heterotrichia Gabriellae* Mass. Mon., 140 (1892); Macbr. l.c., 198.

Pl. 173.—*a.* sporangia; *b. c.* threads from upper part of capillitium; *d.* thread from basal part of capillitium; *e.* capillitium of form named *A. dictyonema* Rost. (Germany); *f.* capillitium of var. *Heterotrichia* (South Carolina); *g.* portion of sporangium-wall; *h.* spores.

The sporangia of this species vary much in colour; large developments are often met with in which the more central sporangia are brick- or orange-red, while the outer are yellow or buff. The markings on the capillitium also vary considerably; the threads of a single sporangium may be in some parts conspicuously thickened on one side while in other parts they are not thickened, and are spinulose all over. In the type of *A. dictyonema* Rost., from Freiburg, the capillitium is spinose, principally on one side of the thread, and marked with broken reticu-

lation and spinules on the other part; there are numerous free branches with clavate or pointed ends; except that the spines are more developed than usual, the markings do not differ from those frequently seen in typical *A. ferruginea*, of which it must be considered a form. The type of *Heterotrichia Gabriellae* Mass, from South Carolina (K. 838), has numerous pointed free ends in the upper part of the net of the capillitium; the threads are flattened, very closely reticulate and spinulose, and in many places thickened on one side; the spores measure 10 to 11  $\mu$ . A similar form has been met with repeatedly in the British Isles when the conditions of development have not been entirely favourable; free ends are usually abundant in sporangia that have matured in cold weather. As this variety is not unfrequent, for convenience of reference we follow Dr. Torrend in distinguishing it as var. *Heterotrichia*. An abnormal form of *A. ferruginea* was found by Prof. Schinz near Goldau, Switzerland, in September, 1902 (B.M. slide); the sporangia are very shortly stalked or sessile, the slender capillitium threads measure 2.5 to 3  $\mu$  diam., and are beaded at short intervals with globular or ovoid swellings, 10  $\mu$  thick, which are marked with a close reticulation of raised bands; the threads between the swellings are nearly smooth; the spores average 10 to 12  $\mu$ , but there are also many monstrous and irregular spores. It is not unusual to find globular expansions in the threads of more normal developments, but this gathering is interesting from their great abundance.

*Hab.* On dead wood. Frequent in the British Isles.—Leytonstone, Essex (B.M. 1493); Lyme Regis, Dorset (B.M. slide); Leighton, Beds (B.M. 1492); Hampstead Park, Birmingham (B.M. 1494); Broseley, Salop (B.M. 3014); Scarborough (B.M. 3015); Alnwick (B.M. 3023); Anglesea (B.M. 1130); Mid-Lothian (B.M. 3016); France (K. 921); Germany (B.M. 727); Norway (Christiania Herb.); Sweden (B.M. 3017); Bohemia (B.M. 3018); Switzerland (B.M. 3019); Portugal (B.M. 3020); German East Africa (B.M. 3021); Ceylon (Paradeniya Herb.); Australia (K. 848); New Zealand (B.M. 3022); Banff, Canada (B.M. 3024); Washington State (B.M. 3025); Maine, U.S.A. (B.M. 1627); Massachusetts (B.M. slide); South Carolina (B.M. 966).

**2. *A. versicolor*** Phillips in Grev., v. 115 (1877). Plasmodium? Total height 2.5 to 3 mm. Sporangia shortly stalked or sessile, gregarious, pyriform or clavate, 1 to 2 mm. diam., more or less shining, yellow or olivaceous-yellow; sporangium-wall membranous, persistent except at the apex, yellow, papillose on the inner side. Stalk membranous, 0.2 mm. long, yellow-brown, filled with spore-like cells, arising from a well-developed hypothallus. Capillitium an elastic network of freely branching yellow threads, 4 to 6  $\mu$  diam., triangular or oval in section, either uniformly spinulose and marked with broken reticulation, or with one side thickened and marked with transverse bars; the threads arise from the tube of the stalk, and are not attached to the sporangium-wall; free ends shortly pointed. Spores yellow, smooth, 8 to 10  $\mu$  diam.—Mass. Mon., 149. *Arcyria vitellina* Phill., l.c.; Macbr. N. Am. Slime-Moulds, 192.

Pl. 175.—*a.* sporangia; *b.* portion of sporangium-wall; *c.* capillitium and spore: (California).

This species has been obtained hitherto from the western States of North America only. It is allied to *A. ferruginea*, from the yellow form of which it differs in shape, in the papillose thickenings of the sporangium-wall, and in the smoother spores. *A. vitellina* Phill. from California is the same species.

*Hab.* On dead wood.—California (B.M. 1495); Colorado (B.M. 3026).

3. *A. cinerea* Pers. Syn. Fung., 184 (1801). Plasmodium greyish-white. Total height 0·8 to 4 mm. Sporangia stalked, gregarious or solitary, single or united in clusters of two to six, ovoid or cylindrical, more rarely globose, 0·5 to 1·2 mm. diam., pale grey, greenish- or bluish-grey, or greyish flesh-colour, sometimes dull yellow; cup of the sporangium-wall membranous, nearly smooth, minutely papillose or reticulated, plaited at the base, pale grey or yellowish. Stalk cylindrical, furrowed, 0·2 to 2 mm. long, 0·05 to 0·15 mm. thick, dark grey or brown, hollow, filled with spore-like cells. Capillitium a close network of grey or yellowish-grey threads; the upper and middle threads 2 to 4  $\mu$  thick, closely warted, transversely banded, or spinulose, the spines often stouter and larger on one side; the threads composing the basal part of the network 4 to 6  $\mu$  thick, either smooth, faintly warted or reticulated, with numerous attachments to the cup. Spores almost colourless, marked with a few scattered warts, 6 to 8  $\mu$  diam.—Rost. Mon., p. 272; Mass. Mon., 151; Macbr. N. Am. Slime-Moulds, 196. *Trichia cinerea* Bull. Champ., 120 (1791). *Stemonitis cinerea* Gmel. Syst. Nat., 1467 (1791). *S. glauca* Trentep. in Roth Catal. Bot., i. 221 (1797). *S. digitata* Schwein. in Trans. Amer. Phil. Soc., n.s. iv. 260 (1832). *Arcyria albida* Pers. in Roemer N. Mag. Bot., i. 90 (1794); Lister Mycetozoa, 186. *A. straminea* Wallr. Fl. Crypt. Germ., iv. 383 (1833)? *A. trichioides* Corda Icon., ii. 23, t. 12, fig. 86 (1838). *A. bicolor* Berk. & Curt. in Journ. Linn. Soc., x. 349 (1869). *A. pallida* Berk. & Curt. in Grev., ii. 67 (1873). *A. digitata* Rost. Mon., p. 274 (1875); Macbr. N. Am. Slime-Moulds, 197. *A. stricta* Rost. Mon., App. p. 36 (1876). *A. Friesii* Berk. & Br. in Ann. Mag. Nat. Hist., ser. 4, xvii. 140 (1876). *A. Cookei* Mass. l.e., 154 (1892). *A. tenuis* Schroet. in Hedw., xxxv. 207 (1896). *Lachnobolus Arcyrella* Rost. Mon., p. 431 (1875)?

Var. *carnea* Lister: sporangia clavate or cylindrical, flesh-coloured; capillitium marked with a loose spiral of flat-topped or almost hooked spinules, minutely warted elsewhere, basal-threads almost smooth or faintly reticulated.

Pl. 176.—*a.* *b.* sporangia; *c.* globose sporangium on bramble stalk; *d.*  $d^1$ . outer threads of capillitium; *e.* spore; (England).

In this species the shape of the sporangium is very variable. An extensive growth of the common grey form arising from one development of plasmodium will often exhibit much diversity; subglobose sporangia with short stalks and subcylindrical sporangia with long stalks are found in company with the more usual ovoid form, and are either single, or are combined in clusters of two to five, when they correspond with the form named *A. digitata* Rost. Groups are met with on dead bramble stems and holly leaves in which the nearly white scattered or clustered sporangia are shortly stalked and perfectly globose, 0.5 to 0.7 mm. diam.; these are associated with other groups of sporangia varying in shape from subglobose to ovoid. Specimens from North and South America and from the tropics are usually elongated or cylindrical. The markings on the capillitium vary also. In some gatherings of the grey form the threads are slender and of nearly uniform thickness throughout, and are either spinulose, with the spines minute and equally distributed, or are marked with a band of larger spines 1 to 3  $\mu$  long, either sharp-pointed or thickened at the apices, arranged in a loose spiral; in other gatherings, especially in cold weather developments, the threads are broad, 5  $\mu$  diam., and papillose all over. The type specimen of *A. Friesii* Berk. & Br. from Glamis, N.B. (K. 896), is a bluish-grey ovoid form of the present species, with typical capillitium and spores. *A. digitata* Rost. is the cylindrical form of *A. cinerea*, with sporangia mostly in clusters of three to seven together: the stalks usually equal the sporangia in length, and, though adhering, are easily separable; the "*botrytis*" arrangement cannot be viewed as having any specific value. The type of *A. Cookei* Mass., from Brazil (K. 865), is a tall grey form of *A. cinerea*; the sporangia measure 2 mm. in length, 0.5 mm. in breadth; the stalks are 2 mm. long, 0.1 mm. thick; the capillitium and spores are quite typical. The var. *carnea*, with flesh-coloured sporangia and compact capillitium somewhat resembles pale forms of *A. stipata*, but shows no trace of spiral markings on the threads.

*Hab.* On dead wood, twigs, and more rarely on leaves. Common.—Batheaston, Somerset (B.M. 276); Charton, Devon (B.M. 1497); Luton Hoo, Beds (B.M. 1498); Bromsgrove, Worcester (B.M. 1500); Sibbertoft, Norths (K. 896); Chatsworth, Derby (B.M. 3027); North Wales (B.M. 3028); Aberdeen (B.M. 3029); Ireland (B.M. 3030); France (K. 859); Germany (B.M. 713); Poland (Strassb. Herb.); Austria (B.M. 1836); Switzerland (B.M. 3031); Italy (B.M. 1973); Portugal (B.M. 3032); Cape (K. 858); Ceylon (B.M. 3033); Java (B.M. 3034); Borneo (B.M. slide); Australia (B.M. 714); New Zealand (B.M. 3035); Tonga Tabu (B.M. 3036); Japan (B.M. 2021); Montreal, Canada (B.M. 3037); Iowa (B.M. 828); Philadelphia (B.M. 1851); South Carolina (B.M. 972); Nicaragua (B.M. 1030); Dominica (B.M. 1757); Brazil (B.M. 3038); var. *carnea*—Bohemia (B.M. 3039); Holstein (B.M. 3040).

4. *A. pomiformis* Rost. Mon., p. 271 (1875). Plasmodium white. Sporangia scattered, stalked, subglobose or ovoid, 0.3 to 0.7 mm. diam., ochraceous-yellow; cup of sporangium-wall plaited at the base, nearly smooth, faintly reticulated or papillose. Stalk slender, buff, 0.2 to 0.4 mm. high, filled with spore-like cells. Capillitium a loose elastic network of yellowish

threads, about  $3\ \mu$  diam., marked with transverse bands and spines arranged in an open spiral, nearly smooth elsewhere. Spores nearly colourless, 7 to  $8\ \mu$  diam., marked with a few scattered warts.—Maebr. N. Am. Slime-Moulds, 197. *Mucor pomiformis* Leers Fl. Herborn., 218 (1775)? *Stemonitis pomiformis* Roth Fl. Germ., 548 (1788)? *S. ochroleuca* Trentep. in Roth Catal. Bot., i. 221 (1797). *S. lutea* Trentep. l.c. *Arcyria umbrina* Schum. Enum. Pl. Saell., ii., 213 (1803)? *A. silacea* Ditm. in Sturm Deutsch. Fl., Pilze, 15, t. 8 (1817). *A. lutea* Schwein. Syn. Fung. Carol., 37 (1822). *A. ochroleuca* Fr. Syst. Myc., iii. 181 (1829). *A. albida* var. *pomiformis* Lister Mycetozoa, 186 (1894).

Pl. 176.—*f.*  $\mu$ , outer threads of capillitium net (England).

Closely allied to *A. cinerea*, and connected with it by numerous gatherings of intermediate character. The basal threads of the capillitium are sometimes marked with three or four faint spiral bands.

*Hab.* On dead wood.—Uplyme, Devon (B.M. 3050); Bath-easton, Somerset (B.M. 278); New Forest, Hants (B.M. 3041); Whitchurch, Oxon (B.M. 3042); Hampstead Park, Birmingham (B.M. 1501); Caddington, Beds (B.M. 3043); Witley, Surrey (B.M. 3044); Epping Forest, Essex (B.M. 3045); Yorks. (B.M. 3046); Mid-Lothian (B.M. 3051); North Germany (B.M. 2236); Poland (Strassb. Herb.); Switzerland (Zürich Herb.); Portugal (B.M. 3047); Japan (B.M. 3048); New Jersey (K. 877); Maine, U.S.A. (B.M. 1629); Philadelphia (B.M. 1927); Colorado (B.M. 3049).

5. *A. globosa* Schwein. Syn. Fung. Carol., 38 (1822). Plasmodium? Sporangia scattered or gregarious, stalked, globose, 0.3 to 0.6 mm. diam., white, pale yellow or brownish; cup of sporangium shallow or rather deep, membranous, smooth or papillose, often minutely and transversely wrinkled. Stalk pale yellow or brown, slender, 0.2 to 0.5 mm. high, filled with spore-like cells. Capillitium a close and only slightly elastic network of colourless threads, 2 to  $4\ \mu$  diam., marked with warts or spines usually arranged along three or four spiral lines that are seen to run from the left above to the right below when the thread is viewed horizontally (in the reverse direction to the spirals of *Trichia elaters*); sometimes the threads are irregularly reticulated below the spines. Spores colourless, 6 to  $8\ \mu$  diam., marked with a few scattered warts.—Petch in Ann. Perad., iv. 365. *Craterium globosum* Fr. Syst. Myc., iii. 154 (1829). *Lachnobolus globosus* Rost. Mon., p. 283 (1875); Mass. Mon., 137; Maebr. N. Am. Slime-Moulds, 187. *Arcyria albida* var. *globosa* Lister Mycetozoa, 186 (1894).

Pl. 176.—*g.* sporangium on chestnut-bur (Alleghany Mountains); *h.* capillitium; *i.* sporangia on male flower of chestnut.

This species was transferred by Rostafinski to the genus *Lachnobolus*, but its chief features—the stalked sporangia, the persistent cup of the sporangium-wall and the somewhat elastic capillitium, are characteristic



rather of *Arcyria*. *A. globosa* is distinguished from *A. cinerea*, its nearest ally, by the globose shape of the sporangia, the less elastic capillitium, and usually by the spiral arrangement of the markings on the threads. An indication of spiral markings sometimes occurs in some of the threads of *A. cinerea*, but less definitely than in the present species and in the reverse direction. Although in North America *A. globosa* appears frequently on the burs and male catkins of the "Chinquapin" (*Castanea sativa* Mill. var. *americana*), it is found there also on dead leaves. Mr. Petch has extended our knowledge of its range by discovering a group of about a dozen typical sporangia on a dead leaf at Peradeniya, Ceylon.

*Hab.* On dead leaves, and the burs and male flowers of *Castanea sativa* var. *americana*.—New York (B.M. 3052); Ohio (K. 882); Philadelphia (B.M. 1871); West Virginia (B.M. 1802); Ceylon (B.M. 3053).

6. *A. annulifera* Torrend Fl. Myx., 102 (1909). Plasmodium? Sporangia scattered, stalked, subglobose or ovoid, 0.5 to 0.6 mm. diam., buffish-yellow; cup of sporangium-wall membranous, papillose, buff, rather deep, with an irregular margin, plicate below. Stalk buff, 0.2 to 0.4 mm. high, filled with spore-like cells. Capillitium a somewhat flaccid network of slender yellowish threads, 1 to 1.5  $\mu$  diam., marked at intervals of 1 to 2  $\mu$  with prominent ring-shaped thickenings 1  $\mu$  diam., basal threads 2  $\mu$  diam., marked with a series of moniliform swellings 2 to 3  $\mu$  long. Spores pale yellow, nearly smooth or marked with a few scattered warts, 6 to 7  $\mu$  diam.—Torrend in Bull. Soc. Port. Sci. Nat., ii. 73 (1908) (*nomen*).

Pl. 185.—*c.* sporangia; *d.* spores and capillitium with fragment of sporangium-wall; (Portugal).

This species closely resembles *A. pomiformis*, but is distinguished by the more slender capillitium being marked with complete annular thickenings. The only example hitherto obtained is the type gathered by Dr. C. Torrend, near Cintra, in the spring of 1908.

*Hab.* On pine needles.—Portugal (B.M. 3054).

7. *A. denudata* Sheldon in Minn. Bot. Studies, i. 470 (1895). Plasmodium white. Total height 2 to 3 mm. Sporangia stalked, crowded or gregarious, ovoid or sub-cylindrical, 0.9 to 1.8 mm. high, 0.8 to 1 mm. broad, crimson, weathering to reddish-brown or brown, rarely pale red; cup of sporangium-wall membranous, firm, shining, plaited, smooth or marked with scattered papillae and faint broken reticulations on the inner side. Stalk cylindrical, 0.5 to 1 mm. high, 0.1 mm. thick, furrowed, red-brown, filled with spore-like cells. Capillitium a rather close elastic network of flattened or terete pale red threads, 2 to 5  $\mu$  diam., with thickenings in the form of prominent cogs or spines and half-rings arranged in a loose spiral; with many attachments to the cup, and usually without free ends. Spores pale red, nearly smooth, but marked with a few scattered warts, 6 to 8  $\mu$  diam.—Macbr. N. Am. Slime-Moulds, 195. *Clathrus denudatus* L.

Syst. Nat., 1179 (1753). *Mucor clathroides* Scop. Fl. Carn., ed. 2, ii. 493 (1772). *M. pyriformis* Leers Fl. Herborn, 288 (1775). *Stemonitis coccinea* Roth Fl. Germ., 548 (1788). *S. crocea* Gmel. Syst. Nat., 1467 (1791). *Embolus crocatus* Batsch Elench. Fung., Cont. i. 265, fig. 177 (1786). *Trichia denudata* Vill. Pl. Dauph., 1060 (1789). *T. graniformis* Hoffm. Veg. Crypt., i. 3 (1790). *T. cinnabarina* Bull. Champ., 121, t. 502, fig. 1, b, c. (1791). *T. purpurea* Schum. Enum. Pl. Saell., ii. 211 (1803)? *Arcyria punicea* Pers. in Roemer N. Mag. Bot., i. 90 (1794); Rost. Mon., p. 268; Lister Mycetozoa, 188. *A. carnea* Schum. l.c., 213? *A. dentata* Schum. l.c.? *A. rufa* Schum. l.c., 214? *A. melanocephala* Schum. l.c.? *A. conjugata* Schum. l.c., 215. *A. cincta* Schum. l.c.? *A. fusca* Fr. Symb. Gast., 17 (1818)? *A. vernicosa* Rost. Mon., App. p. 36 (1876).

Pl. 174.—*a*. sporangia; *b*. capillitium threads, showing attachment to cup and spore; *c*. spinulose capillitium from another sporangium; (England).

This abundant and widely distributed species shows considerable variety in the colour and markings of the capillitium and in the thickness of the threads. In some gatherings the threads are stout, dark red, and rough with close-set cogs and spines, in others they are pale pink and the markings consist only of a loose spiral of smooth cogs or half-rings. A long-stalked rose-coloured specimen, gathered by Rev. W. Cran in Antigua (B.M. 1686), shows extremely slender threads  $2\ \mu$  diam. marked only with a spiral of prominent transverse bands  $1.5\ \mu$  in depth; the capillitium is firmly attached to the shallow cup. Forms of *A. denudata* occur in which some threads of the capillitium show, beside the usual markings, an irregular reticulation, or an indication of three or four faint spiral bands, suggesting an approach to *A. stipitata*.

*Hab.* On dead wood; common.—Batheaston, Somerset (B.M. 254); Lyme Regis, Dorset (B.M. 1506); Epping Forest, Essex (B.M. 1505); Abbey Wood, Kent (B.M. 1153); Highgate, Middlesex (B.M. 1149); Yorks (B.M. 1146); North Wales (B.M. 3055); Aberdeen (B.M. 3056); Ireland (B.M. 3057); France (B.M. 707); Germany (B.M. 708); Sweden (B.M. 3058); Poland (Strassb. Herb.); Switzerland (B.M. 3059); Italy (B.M. 705); Portugal (B.M. 3060); Cameroons, West Africa (B.M. 3061); Cape (K. 898); Ceylon (B.M. 709B); Singapore (B.M. 1938); Java (K. 1715); Borneo (B.M. 1508); New Zealand (B.M. 3062); Philippine Islands (B.M. 2033); Japan (B.M. 2025); Vancouver, B.C. (B.M. 3063); Toronto (B.M. 3064); Iowa (B.M. 1029); Kansas (B.M. 3065); Philadelphia (B.M. 1850); South Carolina (B.M. 982); Antigua (B.M. 1686); Dominica (B.M. 1758); Cuba (K. 950); New Granada (K. 1724); French Guiana (Paris Herb.); Brazil (K. 899).

8. *A. insignis* Kalchbr. & Cooke in Grev., x. 143 (1882). Plasmodium watery-white. Total height 0.5 to 1.5 mm. Sporangia stalked, gregarious or clustered in scattered groups, ovoid or cylindrical, 0.3 to 0.4 mm. diam., pale or bright rose-coloured; cup of sporangium-wall delicately membranous, plaited, nearly smooth or reticulated and spinulose. Stalk thickened

upwards, furrowed, 0.2 to 0.4 mm. long, red, filled with spore-like cells. Capillitium a close elastic network of almost colourless delicate threads, varying in width from 2 to 5  $\mu$ , usually with a few bulbous free ends, flattened, marked with thickenings in the form of faint transverse bands and short spines arranged in a lax spiral, closely and minutely spinulose or nearly smooth elsewhere. Spores when magnified almost colourless, nearly smooth, 6 to 8  $\mu$  diam.—Mass. Mon., 148; Torrend Fl. Myx., 99; Petch in Ann. Perad., iv. 366.

Pl. 181.—*a.* sporangia; *b.* spores, and capillitium showing attachment of threads to the cup; (United States).

This widely distributed species somewhat resembles a small form of *A. incarnata*, but is distinguished by the pure rosy colour of the sporangia, and the closer network of the capillitium, the threads of which are extremely flaccid when mounted in water and are attached to the wall of the cup. Mr. Petch writes (l.c.) that in 1905 the small pale rose-coloured clusters of *A. insignis* were abundant on decaying branches in a deserted garden at Peradeniya. A remarkable variety of the present species was found by him at Pattipola, Ceylon (B.M. 3069), with rosy-scarlet sporangia, the capillitium of which expands into long slender columns 2 mm. high, and shows few, or in some cases no attachments to the plaited funnel-shaped cups: the threads are more terete and uniform in thickness than usual, and have more prominent and distant markings. This gathering is connected with typical *A. insignis* by a specimen obtained by Dr. G. Malmé at St. Angelo, Brazil (B.M. 3071); here the unexpanded sporangia are also narrowly cylindrical, 1 to 1.3 mm., and bright rose-coloured, while the capillitium is attached to the cup and consists of flattened threads varying in diameter from 2 to 8  $\mu$ , and marked with a loose spiral of close delicate transverse bands.

*Hab.* On dead wood.—Germany (B.M. 1731); Portugal (B.M. 3066); Cameroons, West Africa (B.M. 3067); Cape (K. 895); Natal (K. 949); Ceylon (B.M. 3069); Java (B.M. 3068); Japan (B.M. 3070); Manchester, Massachusetts (B.M. 1760); Antigua (B.M. 1687); Brazil (B.M. 3071).

9. *A. glauca* Lister ex Minakata in Bot. Mag. Tokyo, xxii. 322 (1908). Plasmodium? Sporangia stalked, grouped in clusters of four to twenty, ovoid or cylindrical, 0.4 to 2.5 mm. high and 0.4 to 0.8 mm. broad when expanded, pale glaucous-green; cup of sporangium-wall funnel-shaped, membranous, somewhat plaited, marked with a faint reticulation. Stalk pale green or greyish-brown, curved and weak, 0.2 to 0.3 mm. high, filled with spore-like cells. Capillitium an elastic network of pale threads, 2.5 to 3  $\mu$  diam., with many attachments to the cup and few rounded free ends, marked with a loose spiral of prominent cog-like transverse bands, elsewhere either nearly smooth or with thickenings in the form of scattered spinules and an irregular reticulation or with three or four faint spiral lines. Spores pale glaucous, nearly smooth, 7  $\mu$  diam.

Pl. 182.—*a.* sporangia; *b.* capillitium and spores, with fragment of sporangium-wall showing attachment of the capillitium threads; (Japan).

This rare and beautiful species has been found twice only, in the summer of two successive years, by Mr. Kumagusu Minakata. It appeared on a rotting limb of a Chinese Camphor-tree (*Machilus Thunbergii* Sieb. & Zucc.) growing by a shrine of the Shinto monkey-god at Itoda, in the province of Kii, Japan. The shrine has since been removed and the grove surrounding it cut down. When freshly gathered, *A. glauca* is of a pale glaucous or bluish-green colour; after a time it fades to greenish-drab. The markings of the capillitium somewhat resemble those of *A. insignis*.

*Hab.* On dead wood.—Kii, Japan (B.M. 3072).

10. *A. incarnata* Pers. Obs. Myc., i. 58, t. v, figs. 4, 5 (1796). Plasmodium white. Sporangia stalked or nearly sessile, crowded, subcylindrical or ellipsoid, 1 to 1.5 mm. high, 0.6 mm. broad, pink or flesh-coloured; cup of sporangium-wall membranous, even or interruptedly plicate, spinulose. Stalk weak, 0.1 to 0.3 mm. long, flesh-coloured, filled with spore-like cells. Capillitium a very loose elastic network of pale pink threads, 3 to 5  $\mu$  diam., sparingly and somewhat irregularly branched, with here and there broad perforated or ring-like expansions, often swollen at the axils of the branches; thickenings in the form of sharp cogs, half rings, or spines arranged in a loose spiral, and of minute scattered spinules; free ends more or less numerous, clavate or pointed, spinose. Spores pale pink, smooth or with a few scattered warts, 6 to 8  $\mu$  diam.—Rost. Mon., p. 275; Mass. Mon., 145; Macbr. N. Am. Slime-Moulds, 193. *Stemonitis incarnata* Pers. in Gmel. Syst. Nat., 1467 (1791). *S. carnea* Trentep. in Roth Catal. Bot., i. 222 (1797)? *S. globosa* Trentep. l.c.? *Clathrus adnatus* Batsch Elench. Fung., 141 (1783)? *Trichia flexuosa* Schum. Enum. Pl. Sacell., ii. 209 (1803). *Arcyria lilacina* Schum. l.c., 212. *A. minor* Schwein. in Trans. Amer. Phil. Soc., n. s. iv. 259 (1832)? *A. adnata* Rost. Mon., App. p. 36 (1876). *A. irregularis* Racib. in Rozpr. Mat. Przyr. Ak. Krak., xii. 83 (1884).

Var. *fulgens* Lister: sporangia crimson; stalks firm, dark reddish-brown.—*A. affinis* Rost. Mon., p. 276 (1875)? *A. similis* Racib. in Rozpr. Mat. Przyr. Ak. Krak., xii. 81 (1884)?

Pl. 177.—a. sporangia; b. capillitium and spore, with fragment of sporangium-wall; (England).

This species is closely allied to *A. denudata*, from which it is chiefly distinguished by the capillitium having free ends and being without attachments to the cup, and by the more diffusely expanding net; intermediate forms are of not infrequent occurrence.

*Hab.* On dead wood.—Devon (B.M.1509); Epping Forest, Essex (B.M.1510); Batheaston, Somerset (B.M. 270); Sutton Park, Warwick (B.M.1511); Liverpool (B.M. 3073); North Wales (B.M. 3074); Edinburgh (K. 886); Ireland (B.M. 3075); France (Paris Herb.); Germany (B.M. 719); Norway (B.M. 3076); Finland (B.M. 704A); Poland

(Strassb. Herb.); Bohemia (B.M. 3077); Switzerland (B.M. 3078); Portugal (B.M. 3079); South-west Africa (B.M. 1634); Java (B.M. 3080); Australia (K. 892); New Zealand (B.M. 3081); Washington State (B.M. 3082); Colorado (B.M. 3083); Kansas (B.M. 3084); Philadelphia (B.M. slide); South Carolina (K. 843): var. *fulgens*: Epping Forest (B.M. 3085); Luton, Beds (B.M. 3086); Staffordshire (B.M. 3087).

**11. *A. stipata*** Lister Mycetozoa, 189 (1894). Plasmodium? Total height 1.5 to 2 mm. Sporangia stalked or nearly sessile, crowded, cylindrical, erect or curved, 1 to 1.5 mm. high, 0.6 mm. broad, either copper-coloured, or deep brown with a carmine tinge or scarlet; sporangium-wall irregularly evanescent above, the cup plaited and smooth below, papillose or faintly reticulated at the rim. Stalk cylindrical, 0.1 to 1 mm. long, red-brown or brownish-black, filled with spore-like cells, rising from a membranous hypothallus. Capillitium a more or less elastic network of freely branching threads, 2.5 to 3.5  $\mu$  diam., marked with a loose spiral of broad-based spines or transverse ridges, and with three to four faint spiral bands, sometimes with minute spines in addition; with many free clavate ends and few attachments to the cup. Spores pale red, smooth, or with few scattered warts, 6 to 8  $\mu$  diam.—Petch in Ann. Perad., iv. 367. *Leangium stipatum* Schwein. in Trans. Amer. Phil. Soc., n.s. iv. 258 (1832). *Hemiarcyria stipata* Rost. Mon., App. p. 41 (1876). *Hemitrichia stipata* Macbr. N. Am. Slime-Moulds, 204 (1899); Torrend Fl. Myx., 107.

Pl. 178.—*a.* sporangia, with expanded capillitium; *b.* threads of upper part of capillitium; *c.* threads from base of capillitium; *d.* spore (Ceylon); *e.* sporangia (Iowa); *f.* upper part of capillitium; *g.* threads from base of capillitium.

This species is widely distributed, and appears to be especially abundant in the United States. The faint spirals on the threads are often only evident in parts of the capillitium, and are usually most conspicuous on the basal threads; the latter are almost free from spines and transverse bands. The sporangia vary much in colour and in the length of their stalks. Some developments are nearly sessile, and have closely compacted curved copper-coloured sporangia with deep ill-defined cups, and a loose network of flaccid capillitium, the threads of which are sometimes nearly smooth. In other gatherings the sporangia are deep red, scarlet or coppery, the stalks are long, the cups well-defined, and the capillitium forms an elastic network of freely branching threads marked with close-set blunt-ended transverse bands and numerous spinules. Faint spiral bands are also met with occasionally in *A. pomiformis*, *A. globosa* and *A. Oerstedtii*, but their presence does not appear to be a sufficient reason for removing these species from the genus *Arcyria*.

*Hab.* On dead wood.—Reigate, Surrey (B.M. 1718); Holsten. (B.M. 3088); Finland (K. 933); Ceylon (B.M. 709); Nepal (K. 951); Fiji (B.M. 3089); Iowa (B.M. slide); Maine (B.M. 1632); New Hants (B.M. 3090); Philadelphia (B.M. 950).

**12. *A. nutans*** Grev. Fl. Edin., 455 (1824). Plasmodium watery-white. Sporangia stalked, clustered, cylindrical, when

unexpanded 1.5 to 2 mm. high, 0.3 to 0.5 mm. broad; ochraceous-yellow or pale buff; cup of sporangium-wall membranous, flaccid, reticulated and often spinulose on the inner side, interruptedly plicate. Stalk buff, short, or elongated and weak, filled with spore-like cells. Capillitium a very elastic network of pale yellow terete or flattened threads 3 to 4  $\mu$  diam., expanding into a drooping column 8 to 12 mm. in length, free from the cup, or with few attachments; thickenings on the threads in the form of sharp spines and half-rings arranged in a loose spiral, and of scattered spinules and short lines of broken reticulation; free ends more or less numerous, clavate. Spores pale yellow, nearly smooth, marked with a few scattered warts, 6 to 8  $\mu$  diam.—Rost. Mon., p. 277; Mass. Mon., 150; Macbr. N. Ann. Slime-Moulds, 191. *Trichia nutans* Bull. Champ., 122, t. 502, fig. 3 (1791). *T. elongata* Schum. Enum. Pl. Saell., ii., 209 (1803). *Stemonitis nutans* Gmel. Syst. Nat., 1467 (1791). *S. amoena* Trentep. in Roth Catal. Bot., i. 222 (1797). *Arcyria flava* Pers. in Roemer N. Mag. Bot., i. 90 (1794); Lister Mycetozoa, 190. *A. alutacea* Schum. l.c., 212.

Pl. 179.—*a* sporangia; *b*. capillitium and spores with fragment of cup of sporangium-wall; (England).

*Hab.* On dead wood; abundant in the British Isles.—Kent (B.M. 1151); Camden Town, London (B.M. 1152); Leytonstone, Essex (B.M. 1513); Batheaston, Somerset (B.M. 289); Lyme Regis, Dorset (B.M. 1514); Leicester (B.M. 284); Boynton, Yorks (B.M. 1148); Northumberland (B.M. 3091); North Wales (B.M. 3092); France (B.M. 970); Germany (B.M. 722); Poland (Strassb. Herb.); Switzerland (B.M. 3093); Ceylon (Peradeniya Herb.); Java (B.M. 3094); Christmas Island, Java (B.M. 1743); Australia (B.M. 725); New Zealand (B.M. 3095); Banff, Alberta (B.M. 3096); Toronto (B.M. 3097); Newfoundland (B.M. 1780); Iowa (B.M. slide); Kansas (B.M. 3098); Colorado (B.M. 3099); South Carolina (B.M. 969); Bahama Islands (B.M. 3100).

13. *A. Oerstedtii* Rost. Mon., p. 278 (1875). Plasmodium watery-white. Sporangia stalked, clustered, cylindrical, curved, rising from a common membranous hypothallus, when unexpanded 0.6 to 1.5 mm. high, 0.3 to 0.5 mm. broad, dull crimson; sporangium-wall evanescent above, or persistent only in the form of a few well-defined rounded plates, which are papillose on the inner side, smooth on the margin; cup membranous, papillose, with a smooth rim. Stalks pale red, varying in length, usually very short, weak, filled with spore-like cells. Capillitium an elastic network of pale red nearly terete threads 3 to 5  $\mu$  diam., expanding into a long drooping cylindrical column; thickenings in the form of half rings and sharp spines 1 to 3  $\mu$  long, arranged in a loose spiral, elsewhere marked with scattered spinules, and often with four or five

faint irregular spiral bands; threads attached at numerous points to the persistent plates of the sporangium-wall and with a few attachments to the cup; free ends with spinulose tips are sometimes present. Spores pale red, nearly smooth, marked with few scattered warts, 7 to 8  $\mu$  diam.—Mass. Mon., 147; Macbr. N. Am. Slime-Moulds, 191; Petch in Ann. Perad., iv. 367. *A. vermicularis* Schum. Enum. Pl. Saell., ii. 212 (1803)? *A. punicea* var. *vermicularis* Fr. Syst. Myc., iii. 178 (1829)? *A. incarnata*  $\beta$  *flexuosa* Fr. l.c., 179. *A. fuliginea* Cooke & Mass. l.c., 169. *A. magna* Rex in Proc Acad. Nat. Sci. Phil., 1893, 364; Macbr. l.c., 190. *Hemiarcyria fuliginea* Cooke & Mass. in Grev., xvi. 74 (1888).

Pl. 180.—*a.* sporangia; *b.* shield-like persistent portion of sporangium-wall with capillitium threads attached; *c.* capillitium with fragment of cup, and spore; (England).

A specimen from Baden in Strassb. Herb. marked "*Oerstedt*" is a typical example of the present species. Although nearly allied to *A. nutans*, it differs in colour, and in the spines on the capillitium being more slender and closely set and more evenly distributed; it also differs in the presence of the well-defined persistent portions of the sporangium-wall, which appears to be a very constant feature. Specimens received from different parts of the world possess the same characters with but little variation. The type of *Hemiarcyria fuliginea* Cooke & Mass. from New South Wales (K. 154), has the capillitium attached to persistent papillose plates of the sporangium-wall, and resembles typical gatherings of *A. Oerstedtii*, except in the colour, which is now fuliginous-brown. The constrictions and ovoid swellings in the capillitium, mentioned by Rostafinski as characteristic of this species, frequently occur in irregular developments of *A. incarnata* and other *Arcyriae*, and cannot be held to be of specific value. *Arcyria magna* Rex, and *A. magna* var. *rosea* Rex (B.M. 1518), appear to be forms of the present species. They are respectively tawny-grey and rosy-red in colour. The two varieties have been found twice in Fairmount Park, Philadelphia; each time they were closely associated on the same log of wood. The capillitium expands into long drooping columns, to which in var. *rosea* persistent papillose plates of the sporangium-wall are attached. The sporangial cups are smoother and the markings of the capillitium threads rather stouter than in typical *A. Oerstedtii*.

*Hab.* On dead wood.—Devon (B.M. 1515); Failand, Somerset (B.M. 3101); Sutton, Warwick (B.M. 1517); Runton, Norfolk (B.M. 3102); Mid-Lothian (B.M. 3103); Hamburg (B.M. 3104); Berlin (B.M. 3105); Norway (B.M. 1516); Denmark (K. 893); Switzerland (B.M. 3106); Bohemia (B.M. 3107); Portugal (B.M. 3108); Ceylon (B.M. 3109); Java (B.M. 3110); New South Wales (K. 154); Kansas (B.M. 3111); Philadelphia (B.M. 3112).

14. *A. occidentalis* Lister. Plasmodium? Sporangia stalked or sessile, angled by mutual pressure, ellipsoid, 0.7 to 0.9 mm. high, 0.4 to 0.5 mm. broad, rosy copper-coloured fading to yellowish-buff; sporangium-wall more or less evanescent above,

persistent at the sides and at length dividing into four to six deep rounded membranous and papillose lobes. Stalk yellowish-brown, straight or curved, 0.1 to 0.3 mm. high, filled with spore-like cells. Capillitium a loose network of pinkish-yellow threads, 2.5 to 4  $\mu$  diam., with few attachments to the sporangium-wall, marked with spines, warts, and low transverse bands arranged in a lax spiral, otherwise nearly smooth or minutely papillose; free ends more or less numerous, clavate, papillose. Spores flesh-coloured, smooth except for a few scattered warts, 6 to 7  $\mu$  diam.—*Lachnobolus incarnatus* Macbr. in Bull. Nat. Hist. Iowa, ii. 126 (1892). *L. occidentalis* Macbr. N. Am. Slime-Moulds, 188 (1899).

Pl. 192.—*a.* sporangia; *b.* capillitium and spores with fragments of sporangium-wall: (Iowa).

This species somewhat resembles the smaller forms of *A. stipata*, but is distinguished by the cup of the sporangium dividing into rounded lobes, and in the absence of spiral bands on the threads of the capillitium. The flaccid character of the capillitium is not more marked than in many gatherings of *A. stipata*, and can hardly be regarded as of sufficient importance to separate *A. occidentalis* from the genus *Arcyria*.

*Hab.* On dead wood.—Winnipeg, Manitoba (B.M. 3113); Iowa (B.M. 1027); New Hants, U.S.A. (B.M. 3114). †

Genus 44.—**LACHNOBOLUS** Fries Fl. Scan., 356 (1835), amended. Sporangia sessile, clustered; sporangium-wall single, membranous, somewhat persistent, not thickened with angular granules; capillitium a loose inelastic network of cylindrical threads, with thickenings in the form of closely set warts.

1. *L. congestus* Lister. Plasmodium? Sporangia subglobose, sessile, clustered and heaped, 0.5 to 0.8 mm. diam., pale copper-colour or ochraceous, shining; sporangium-wall membranous, firm, papillose, pinkish or ochraceous-yellow. Capillitium a network of freely-branching flaccid pink or ochraceous-yellow threads, irregular, varying from 2 to 8  $\mu$  diam., closely and equally studded with prominent warts and attached at numerous points to the sporangium-wall. Spores pale pink or yellow, faintly and minutely warted, and with a few scattered stronger warts, 6 to 8  $\mu$  diam.—*Physarum congestum* Somm. Fl. Lapp., 241 (1826). *Arcyria circinans* Fr. Stirp. Femsj., 83 (1827)? *A. (Lachnobolus) congesta* Berk. & Br. in Ann. Mag. Nat. Hist., ser. 4, xvii. 140 (1876). *A. Hariotii* Mass. Mon., 155 (1892). *Perichaena congesta* Fr. Syst. Myc., iii. 192 (1829). *Licea congesta* Wallr. Fl. Crypt. Germ., 345 (1833). *Lachnobolus circinans* Fr. Summ. Veg. Scand., ii. 457 (1849)? Rost. Mon., p. 282; Lister Mycetozoa, 194. *L. Sauteri* Rost. in Fuckel Symb.



Myc., Nachtr. 76 (1873). *L. incarnatus* Schroet. in Cohn Krypt. Fl. Schles., iii. pt. 1, 110 (1885); Mass. Mon., 138.

Pl. 183.—*a.* sporangia; *b.* capillitium and spores with fragment of sporangium-wall; (England).

The small sporangia of this species are often heaped together to form large hemispherical clusters 5 to 8 mm. across and 3 to 5 mm. thick; around the larger groups a few isolated sporangia are usually scattered. When freshly formed their colour is pale copper-colour, but this soon fades to dull ochraceous-yellow. The description of *Perichaena congesta* (Somm.) Fr. applies fairly well to the present species. Fries's account of *Arcyria* (*Lachnobolus*) *circinans*, however, with its large rusty-red sporangia, fugacious sporangium-walls, rust-coloured spores, and compact globose masses of brown capillitium, is not so appropriate, and may possibly refer to a stunted form of *A. ferruginea*; but in the absence of the type this must remain conjectural.

*Hab.* On dead wood.—Somerset (B.M. 291); Epping Forest, Essex (B.M. 3115); Haypit, Stafford (B.M. 1519); Alderley Edge, Cheshire (B.M. 3116); France (Paris Herb.); Brussels (B.M. 3117); Sweden (B.M. 3118); Tyrol (Strassb. Herb.); Bohemia (B.M. 3119).

Genus 45.—**PERICHAENA** Fries Symb. Gaster., 11 (1817). Sporangia subglobose, sessile or forming plasmodiocarps, rarely shortly stalked; sporangium-wall of two layers (single in *P. microspora*), the outer thickened with angular granules which are exceptionally absent in the upper part, the inner usually membranous; capillitium of branching or simple, tubular, inelastic threads, spinose, minutely warted, or nearly smooth, usually marked with irregular constrictions; spores yellow or brown, minutely warted.

## KEY TO THE SPECIES OF *PERICHAENA*.

A. Sporangium-wall firm, double :—

A. Sporangia brown or grey—

Sporangia subglobose or forming plasmodiocarps; capillitium spinose; spores 8 to 10  $\mu$  diam. 1. *P. chrysosperma*

Sporangia flattened; capillitium minutely warted, abundant; spores 10 to 11  $\mu$  diam. 2. *P. depressa*

Sporangia subglobose; capillitium warted or nearly smooth, usually scanty; spores 11 to 14  $\mu$  diam.

3. *P. corticalis*

B. Sporangia stalked, purple-red or purple-brown.

4. *P. pulcherrima*

B. Sporangium-wall membranous :—

Sporangia pale umber or buff; spores 10  $\mu$  diam.

5. *P. vermicularis*

Sporangia flesh-coloured; spores 6  $\mu$  diam.

6. *P. microspora*

1. *P. chrysosperma* Lister. Plasmodium pale brown. Sporangia scattered, sessile, rarely shortly stalked, subglobose or forming curved or ring-shaped plasmodiocarps, 0.4 to 1 mm. diam., chestnut, red-brown or blackish-brown, dehiscing irregularly; sporangium-wall of two layers, the outer composed of brown granular matter, which either forms a complete crust, or is more or less obsolete; the inner layer subcartilaginous, pale yellowish-olive, translucent. Stalk, when present, stout, black, 0.1 to 0.7 mm. high. Capillitium abundant, forming a loose network of sparingly branched yellow threads 2 to 4  $\mu$  diam., irregularly constricted, studded with scattered spinules or curved spines, 1 to 6  $\mu$  long. Spores citron-yellow in mass, minutely warted, 9 to 10  $\mu$  diam., rarely 7 to 8  $\mu$ .—Torrend Fl. Myx., 90; Petch in Ann. Perad., iv. 368. *Ophiotheca chrysosperma* Currey in Quart. Micr. Journ., ii. 240, t. ix. figs. 1-5 (1854); Macbr. N. Am. Slime-Moulds, 182. *O. Wrightii* Berk. & Curt. in Journ. Linn. Soc., x. 349 (1869); Mass. Mon., 132; Macbr. l.c. *O. circumscissa* Mass. l.c., 131. *Trichia circumscissa* Wallr. Fl. Crypt. Germ., 378 (1833)? *T. Curreyi* Crouan Fl. Finist., 16 (1867). *Arcyria glomerata* Fr. Summ. Veg. Scand., 457 (1849)? *Cornuvia circumscissa* Rost. Mon., p. 290 (1875). *C. Wrightii* Rost. Mon., App. p. 36 (1876). *Hemiarcyria melanopeziza* Speg. in Ann. Soc. Cient. Argent., x. 257 (1881).

Pl. 184.—a. stalked and sessile sporangia; b. various forms of capillitium from sporangia on the same piece of bark, with spore and fragment of sporangium-wall.

In Rostafinski's description of the genus *Perichaena* the capillitium is said to be without characteristic thickenings. *P. corticalis* to which this definition most nearly applies has the capillitium threads warted and notched, rarely smooth, while in other species of the genus the threads are never smooth, but are marked with minute warts, spinules or spines. In *P. chrysosperma* there may be considerable difference in the amount of roughness of the capillitium in a single group of sporangia. In a gathering made at Lyme Regis, two of the sporangia examined have almost smooth threads marked only with a few minute scattered spines, other sporangia have spines 2.5  $\mu$  long, and others have the threads studded with curved spines 5 to 6.5  $\mu$  long. The type of *Ophiotheca chrysosperma* Currey (B.M. 308) has the capillitium marked with spines 1 to 4  $\mu$  long. The type of *Cornuvia Wrightii* Rost. from Cuba (B.M. 699) shows sporangia similar in all respects to Currey's gathering. From the original account of *Trichia circumscissa* Walloth it is probable that the specimen described was not the present species but *Perichaena depressa*; the specific name given by Currey is therefore here adopted.

*Hab.* On dead bark.—Lyme Regis, Dorset (B.M. 1520); Bohemia (Herb. Dr. Celakovsky); Portugal (B.M. 3120); Ceylon (K. 1712); Japan (B.M. slide); Philadelphia (B.M. 1522); Iowa (B.M. slide); Ohio (B.M. 1521); Cuba (B.M. 699); Antigua (B.M. 1689); Brazil (B.M. 3121).

2. *P. depressa* Libert Pl. Crypt. Ard., fasc. iv. no. 378 (1837). Plasmodium milky - white. Sporangia sessile, crowded, polygonal from mutual pressure, flattened, 0.5 to 1 mm. diam., sometimes forming short branching plasmodiocarps, purple-brown, red-brown, buff or grey, dehiscing along the margin with a well-defined lid; sporangium-wall of two layers, the outer cartilaginous, charged with brown granular matter, often intermixed with angular crystals of lime, more or less closely combined with the membranous smooth inner layer. Capillitium an abundant web of branched slender yellow threads, 1.5 to 2.5  $\mu$  diam., minutely warted or marked with regular close-set constrictions at intervals of 0.5 to 1  $\mu$ , and with irregular expansions. Spores golden-yellow, minutely warted, 8 to 12  $\mu$  diam.—Rost. Mon., p. 292; Mass. Mon., 114; Macbr. N. Am. Slime-Moulds, 183. *Stegasma depressum* Corda Icon., v. 58, t. iii., fig. 34 (1842). *S. australe* Cesati in Hedw., xiii. 186 (1874). *Perichaena artocreas* Berk. & Rav. in Grev., ii. 68 (1873). *P. irregularis* Berk. & Curt. in Grev., ii. 68. *P. marginata* Berk. & Br. in Journ. Linn. Soc., xv. 84 (1876) (*non* Schwein). *P. australis* Berl. in Sacc. Syll., vii. 422 (1888); Mass. l.c., 119. *P. applanata* Mass. l.c., 116 (1892). *P. quadrata* Macbr. l.c., 184? *Hemiarcyria applanata* Cooke & Mass. in Grev., xvi. 20 (1887). *Ophiotheca irregularis* Mass. l.c., 132.

Pl. 189.—*a.* sporangia; *b.* capillitium and spores with a fragment of the double sporangium-wall; *c.* capillitium and spore; (England).

This species is distinguished from *P. corticalis*, to which it is closely allied, by the flattened sporangia and smaller spores. The type of *P. applanata* Mass., from Brisbane (K. 153), is characterised by the outer layer of the sporangium-wall having a superficial crust of angular crystals of lime, which gives the sporangia a lilac-grey colour; in all other respects, in the abundant and minutely-warted capillitium, and in the spores measuring 10 to 11  $\mu$  diam., it agrees with the present species; deposits of lime on the sporangium-wall are of frequent occurrence both in *P. depressa* and in *P. corticalis*, and although they are unusually abundant in the Brisbane specimen, the character is not of sufficient importance to give specific distinction. The type of *P. artocreas* Berk. & Rav. from South Carolina (K. 1027 and B.M. 697) appears also to be *P. depressa*; it has abundant capillitium, and spores measuring 8 to 10  $\mu$ ; the sporangia are polygonal, depressed, and pale brown. The type of *P. irregularis* Berk. & Curt. from South Carolina (K. 1706) is typical *P. depressa*. The type of *Stegasma australe* Ces. from Naples (B.M. 1034) is in imperfect condition, but it appears to be the present species from the many broken pieces of minutely warted capillitium, and the spores, which measure 10 to 11  $\mu$  diam. *Stegasma pallida* Ces. (in Atti Accad. Sc. Fis. Mat., viii. 12, 1879) from Borneo may possibly be a form of *P. depressa*, but the description is too brief to be instructive.

*Perichaena Krupii* Racib. (in Hedw., xxviii. 124 (1889)) is described as having solitary chestnut-brown globose depressed sporangia or

flat creeping plasmodiocarps dehiscing by a lid; capillitium forming a dense web of nearly simple closely warted threads, 0.3 to 1.5  $\mu$  diam., connected with the sporangium-wall by many slender attachments; spores brownish-yellow, minutely warted, 7 to 8.5  $\mu$  diam.—In some respects this description applies to a form of *P. depressa* with very slender capillitium; on the other hand, if the capillitium threads were not tubular but solid, the species might possibly be referred to the genus *Dianema*.

*Hab.* On dead wood and bark, rarely on leaves.—Epping Forest, Essex (B.M. 1523); Lyme Regis, Dorset (B.M. 1524); Hitchin, Herts (B.M. 3122); Yorks (B.M. 3123); Salop (B.M. 3124); Glamis, Scotland (B.M. 323); Ireland (B.M. 3125); Germany (B.M. 688); Belgium (B.M. 690); Poland (Strassb. Herb.); Italy (B.M. 689); Portugal (B.M. 3129); Portuguese East Africa (B.M. 3126); Madagascar (Herb. Dr. Jahn); Ceylon (Peradeniya Herb.); Queensland (K. 153); Japan (B.M. 3127); Colorado (B.M. 3128); Ohio (B.M. 1525); Philadelphia (B.M. 1526); South Carolina (B.M. 697); Antigua (B.M. 1690).

3. *P. corticalis* Rost. Mon., p. 293 (1875). Plasmodium watery-grey. Sporangia crowded or scattered, sub-globose, often depressed, ellipsoid, or forming bolster-shaped plasmodiocarps, sessile on a broad or narrow base, rarely sub-stipitate, 0.5 to 1 mm. diam., dark purple or purplish-brown, nut-brown, grey or white, dehiscing irregularly or along definite lines, and then either horizontally with a convex lid or in broad sinuous lobes; sporangium-wall of two layers, the outer cartilaginous, yellowish-brown, charged with brown granular matter, often intermixed with acicular or angular calcareous deposits which may form a pruinose or crystalline covering in the grey and white sporangia; inner layer membranous, usually closely combined with the outer. Capillitium often scanty or almost wanting, consisting of slender, long or short, branched or simple, weak yellow threads, 1.5 to 4  $\mu$  diam., irregularly compressed, angled and constricted, minutely warted, or marked with short spines and prominences, rarely smooth, either attached to the sporangium-wall or free. Spores yellow, minutely and closely warted, 11 to 14  $\mu$  diam.—Mass. Mon., 115; Macbr. N. Am. Slime-Moulds, 185. *Lycoperdon corticale* Batsch Elench. Fung., 155 (1783). *Sphaerocarpus sessilis* Bull. Champ., 132, t. 417, fig. 5 (1791). *Trichia fusco-atra* Sibth. Fl. Oxon., 407 (1794). *T. gymnosperma* Pers. Obs. Myc., i. 63, t. vi, figs. 1, 2 (1796). *T. circumscissa* Schrad. Nov. Pl. Gen., 19 (1797). *Licca circumscissa* Pers. Syn. Fung., 196 (1801). *L. quercina* Wallr. Fl. Crypt. Germ., 344 (1833)? *Physarum luteo-album* Schum. Enum. Pl. Saell., ii. 199 (1803). *Perichaena populina* Fr. Symb. Gast., 12 (1817); Lister Mycetozoa, 198. *P. quercina* Fr. l.c.? *P. abietina* Fr. l.c., 11. *P. marginata* Schwein. in Trans. Amer. Phil. Soc., n.s. iv. 258 (1832). *P. vaporaria* Schwein. l.c.?

*P. fusco-atra* Rost. Mon., p. 294 (1875). *P. Rostafinskii* Karst. in Bidr. Känn. Finl. Nat., 1879, 130. *P. microcarpa* Schroet. in Cohn Krypt. Fl. Schles., iii. pt. 1, 108 (1885)? *P. cano-flavescens* Raunk. in Bot. Tidssk., 1888, 54? *P. nitens* Raunk. l.c., 55? *Cornuvia dictyocarpa* Krupa in Cosmos, 1886, 377? *Oligonema Broomei* Mass. in Journ. R. Micr. Soc., 1889, 346; Mass. Mon., 172.

Var. 1.—*affinis* Lister: sporangia purple-red or red-brown, dehiscing irregularly, granular deposits of outer sporangium-wall often discontinuous; capillitium forming a somewhat abundant network of rather firm yellowish-brown threads, 2 to 3  $\mu$  diam.; spores 10 to 12  $\mu$ .

Var. 2.—*liceoides* Lister: sporangia subglobose or bolster-shaped, nut-brown, minute, 0.2 to 0.5 mm. diam., dehiscing irregularly; granular deposits of outer sporangium-wall scanty or wanting; capillitium usually scanty; spores 10 to 15  $\mu$  diam.—*Perichaena liceoides* Rost. Mon., p. 295; Mass. Mon., 118. *Licea pannorum* Cienk. (non Wallr.) in Pringsh. Jahrb. Bot., iii. 407 (1863). *Lachnobolus pygmaeus* Zukal in Oester. Bot. Zeitschr., xliii. 136 (1893).

Pl. 186.—a. sporangia; b. capillitium and fragment of sporangium-wall; c. capillitium and spore; (England).

This abundant and widely distributed species shows great variation in the shape and colour of the sporangia, and in the abundance of the capillitium. In large developments from one plasmodium every variety of form is sometimes represented from broad plasmodiocarps to globose and substipitate sporangia, and the colour may range from deep purple to grey. In gatherings where the colour is pure white, the sporangium-wall has an outer covering of crystalline deposits of lime without the intermixture of brown granules. The capillitium is subject to much variation according to the season of the year and other causes. In a gathering made at Lyme Regis in the autumn, the capillitium was scanty, forming a net of rugged coarsely warted threads 2 to 4  $\mu$  diam. with a few scattered free threads; in the following spring another growth on the same pieces of bark had sporangia of a similar shape and colour but with a more abundant capillitium forming a freely branching slender network of minutely warted threads 1 to 1.5  $\mu$  diam., scarcely differing from that of *P. depressa*, the larger spores being the chief character which distinguished the gathering from that species. The specimens named *P. fusco-atra* in the collections differ in no respect from forms of *P. corticalis*, and cannot be held as specifically distinct. The type of *Oligonema Broomei* Mass. from Warleigh (B.M. 364) is typical *P. corticalis* with characteristic branching capillitium threads marked with irregular swellings and spinules, and with minutely and closely warted spores 14 to 15  $\mu$  diam. The var. *affinis* is a form having the capillitium threads of firmer substance and forming a somewhat abundant network. The spores are smaller than in the type. It has been obtained from various parts of England and from Portugal. The var. *liceoides* is a minute form, with translucent sporangium-wall and weak capillitium. It is described by Cienkowski as *Licea pannorum*, l.c., and is given by Rostafinski as the type of a new species, *Perichaena*

*liceoides*, characterised by the scanty capillitium of free threads and the spores measuring 9 to 10  $\mu$ ; Zopf, on the other hand, quotes it as a synonym for *P. corticalis*; and this view is confirmed by the not infrequent occurrence of forms of the latter species with scanty or no capillitium, and spores measuring from 10 to 12  $\mu$ . The type of *Lachnobolus pygmaeus* Zukal, from Carinthia, appears to be the same variety; preparations courteously submitted to us by Prof. F. v. Höhnelt show minute sporangia, 0.1 to 0.2 mm. diam., with walls free from angular deposits, and with scanty, irregular capillitium; the spores in one sporangium measure 10 to 12  $\mu$ , and in another 13 to 15  $\mu$ . The sporangia of *P. corticalis* often closely resemble those of *Trichia contorta* and *Hemitrichia Karstenii*, from which they may be distinguished by the capillitium being more slender and showing no trace of spiral markings.

*Hab.* On dead bark and wood.—Cornwall (B.M. 3130); Batheaston, Somerset (B.M. 309); Lyme Regis (B.M. 3131); Salisbury (B.M. 1528); Warleigh, Somerset (B.M. 364); Brentwood, Essex (B.M. 1527); Shrewsbury (B.M. 322); Beynton, Yorks (B.M. 1160); Alnwick, Northumberland (B.M. 3132); Ireland (B.M. 3133); France (B.M. 1161); Holstein (B.M. 2276); Finland (B.M. 767); Sweden (K. 1702); Switzerland (Strassb. Herb.); Russia (Herb. Dr. Sturgis); Ceylon (B.M. 3134); Singapore (B.M. 3135); Tasmania (K. 1710); British Columbia (B.M. 3136); Ohio (B.M. 1529); Florida (B.M. 987); var. *affinis*.—Alresford, Hants. (B.M. 3137); Aldborough, Yorks. (B.M. 3138); Portugal (B.M. 3139); var. *liceoides*—Berlin (B.M. 3140).

5. *P. pulcherrima* Peteh in Ann. Perad., iv. 305 (1909). Plasmodium? Sporangia scattered and stalked, or clustered and almost sessile on an irregular hypothallus, globose, 0.5 mm. diam., glossy, purple-red or purple-brown; sporangium-wall dehiscing irregularly, of two closely adhering layers, the outer rather stout, purplish-red, with scattered granular deposits, the inner hyaline. Stalks 0.1 to 0.3 mm. high, red-brown, furrowed, containing granular refuse-matter. Capillitium a loose inelastic network of reddish-brown threads, 3 to 4  $\mu$  diam., with few free ends and few attachments to the sporangium-wall; thickenings in the form of scattered warts and straight or curved spines 1 to 2  $\mu$  long. Spores purplish-brown in mass, when magnified pale reddish-brown, closely spinulose, 15 to 17  $\mu$  diam.—Peteh l.c., 370.

Pl. 188.—a. cluster of sessile sporangia; b. capillitium and spores with fragment of sporangium-wall; c. spores, and capillitium showing attachment of threads to sporangium-wall; d. spore and capillitium; (Ceylon).

This species has been found on one occasion only, on the branches of *Theobroma cacao* and *Erythrina lithosperma* by Mr. Peteh at Ukuwela, Ceylon. He obtained a further development a few days later from the same branches after keeping them in a moist chamber. In some cases the sporangium-wall is marked with a reticulation corresponding to the impression of the spores. *P. pulcherrima* is distinguished from other species of the genus by the colour of the sporangia, which resembles that of *Physarum pulcherrimum* Berk. & Rav., and by the comparatively stout brown capillitium threads.

*Hab.* On dead wood.—Ceylon (B.M. 3141).

5. **P. vermicularis** Rost. Mon., App. p. 34 (1876). Plasmodium watery-white or yellowish-white. Sporangia scattered, sessile, globose on a narrow base, 0.5 mm. diam., or forming slender curved or net-like plasmodiocarps, ochraceous-yellow, pale umber or greyish; sporangium-wall of two layers, the outer more or less charged with dark granules and occasionally with angular crystals of lime, closely combined with the membranous papillose inner layer; in some cases the outer layer is not distinguishable in the upper part of the sporangium. Capillitium a profuse network of sparingly branched yellow threads, 2 to 4  $\mu$  diam., rough with minute scattered warts and irregular constrictions. Spores yellow, minutely warted, 10 to 15  $\mu$  diam.—*Physarum vermiculare* Schwein. in Trans. Amer. Phil. Soc., n.s. iv. 257 (1832). *Ophiotheca pallida* Berk. & Curt. in Journ. Linn. Soc., x. 350 (1869). *O. umbrina* Berk. & Curt. in Grev., ii. 68 (1873). *O. vermicularis* Mass. Mon., 134 (1892); Macbr. N. Am. Slime-Moulds, 181. *O. reticulata* Mass. l.c., 133. *Licea reticulata* Berk. & Br. in Journ. Linn. Soc., xiv. 86 (1873). *Perichaena variabilis* Rost. Mon., p. 295 (1875); Lister Mycetozoa, 199; Petch in Ann. Perad., iv. 370. *P. Friesiana* Rost. l.c., p. 296. *P. reticulata* Rost. Mon., App. p. 35. *P. confusa* Mass. l.c., 117.

Var. **pedata** Lister in Journ. Bot., xlii. 139, t. 459, figs. 3a, b (1904); sporangia scattered or in small clusters, subglobose, pale nut-brown or ochraceous-brown, stalked; stalks blackish-brown, rugose, 0.1 to 0.3 mm. high.

*Hab.* On leaves and bark.

Pl. 187.—*a.* sporangia; *b.* capillitium; *c.* capillitium and spores with fragment of sporangium-wall; (England).

The yellow form of this species has appeared in some abundance on leaves and twigs in successive years at Lyme Regis, and corresponds exactly with the type specimen of *Physarum vermiculare* from Schweinitz (K. 1671). The type of *Ophiotheca umbrina* Berk. & Curt. from North Carolina no. 413 (K. 1705), was originally published as *Ophiotheca pallida* Berk. & Curt. It is a pale umber plasmodiocarp form, agreeing in the structure of the sporangium-wall, capillitium, and spores with the English gatherings. Part of this type was sent by Fries to Rostafinski, who described it as "*Perichaena Friesiana*" (Rost. Mon. p. 269); in the appendix to his Monograph, however, *Ophiotheca umbrina* B. & C. is placed as a synonym for *P. variabilis* Rost.; it was probably by an oversight that Rostafinski still retained *P. Friesiana* as a distinct species (Mon., App. p. 35). A specimen from New Jersey from Ellis, no. 726, N. Am. Fungi (K. 990), originally named *P. Friesiana*, and then *O. umbrina*, resembles the Lyme Regis gathering and Rostafinski's description of *P. vermicularis*; these specimens from New Jersey and from Lyme Regis are given as the types of a new species, *P. confusa*, by Massee,

but surely on insufficient grounds. The type of *Licea reticulata* Berk. & Br., from Ceylon (B.M. slide) is also the present species; the sporangia consist of minute pale amber net-like plasmodiocarps, some of which have very scanty capillitium, but in others it is more abundant and of the usual minutely warted type; the spores are closely and minutely warted and measure 11 to 15  $\mu$ . In all the specimens enumerated above, the inner layer of the sporangium-wall is minutely papillose, a character by which this species of *Perichaena* is distinguished from all others. The var. *pedata* is a somewhat doubtful form of the present species. It has firmer, less irregular capillitium than the type, and the sporangium-wall is less distinctly papillose: in these respects it approaches *P. corticalis* var. *affinis*. Two small gatherings only have so far been recorded, viz., one on an ivy-leaf from Lyme Regis, Dorset, obtained by Miss M. J. Lloyd, and one on bark, from Chestnut Hill, Philadelphia, found by Mr. Hugo Bilgram.

*Hab.* On dead leaves, herbaceous stems, bark, etc.—Lyme Regis, Dorset (B.M. 1530); Batheaston, Somerset (B.M. 310); Luton, Beds. (B.M. 3143); Worcester (B.M. 3144); Yorks. (B.M. 3145); Aberdeen (B.M. 3146); Sweden (B.M. 3147); Ceylon (B.M. slide); Java (Herb. Buitenzorg); New Jersey (K. 990); Philadelphia (B.M. 1532); North Carolina (K. 1671); South Carolina (B.M. 953): var. *pedata*—Lyme Regis (B.M. slide).

6. *P. microspora* Penzig & Lister in Penzig Myx. Buit., 76 (1898). Plasmodium? Sporangia forming slender, short, elongated, or net-like plasmodiocarps, 0.25 to 0.35 mm. diam., salmon-pink, glossy; sporangium-wall membranous, single, yellowish, smooth, thickened with deposits of granular matter towards the base only. Capillitium a loose network of slender fragile yellowish-pink threads, 1.5 to 2  $\mu$  diam., marked with minute spines and with shallow constrictions at intervals of 1 to 2  $\mu$ , more or less attached to the sporangium-wall. Spores in mass pinkish-yellow, when magnified pale yellowish, closely and minutely spinulose, 6 to 8  $\mu$  diam.—Petch in Ann. Perad., iv. 369.

Pl. 185.—*a.* plasmodiocarps; *b.* capillitium and spores with fragment of sporangium-wall; (Java).

*Hab.* On dead leaves and twigs.—Ceylon (B.M. 3142); Java (B.M. slide).

It is probable from the description of *Perichaena*? *pseudaeacidium* Speg. (in Ann. Soc. Cient. Argent., xxii. 187, 1886) that this species should be excluded from the *Mycetozoa*.

### ORDER III.—MARGARITACEAE.

Sporangia usually sessile; sporangium-wall single, rarely of two layers in *Dianema*, smooth, usually translucent; capillitium consisting of solid threads, either coiled and hair-like, or nearly straight and attached to the sporangium-walls, simple or branching at an acute angle.



## KEY TO THE GENERA OF MARGARITACEAE.

- A. Sporangia dehiscing irregularly :—  
Capillitium threads profuse, coiled.

(46) MARGARITA.

Fig. 53.—*Margarita metallica* Lister.

- a. Two sporangia. Magnified 6 times.  
b. Part of a long capillitium thread, and a spore.  
Magnified 250 times.

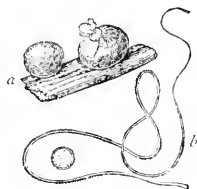


Fig. 53.

- Capillitium of nearly straight slender threads attached above and below to the sporangium-wall.

(47) DIANEMA.

Fig. 54.—*Dianema depressum* Lister.

- a. Plasmodiocarp. Magnified twice.  
b. Capillitium attached above and below to the walls of the sporangium. Magnified 50 times.  
c. Spore. Magnified 560 times.

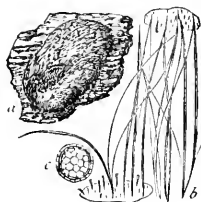


Fig. 54.

- Capillitium threads marked with spiral thickenings, stout below, penicillate and slender above, attached above and below to the sporangium-wall.

(48) PROTOTRICHIA.

Fig. 55.—*Prototrichia metallica* Mass.

- a. Group of sporangia. Magnified 4 times.  
b. Capillitium attached above to a fragment of the sporangium-wall, and a spore. Magnified 280 times.



Fig. 55.

- B. Sporangia dehiscing in lobes; capillitium threads with moniliform thickenings.

(49) LISTERELLA.

Fig. 56.—*Listerella paradoxa* Jahn.

- a. Sporangia. Magnified 50 times.  
b. Capillitium thread and spores. Magnified 460 times.

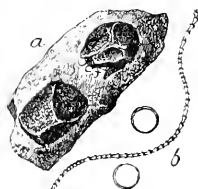


Fig. 56.

Genus 46.—**MARGARITA** Lister Mycetozaa, 203 (1894). Sporangia sessile; sporangium-wall translucent; capillitium a profuse coil of hair-like nearly simple solid threads, with indistinct attachments to the sporangium-wall.

The name *Margarita* is given to the present genus on account of the pearl-like appearance of the sporangia.

1. **M. metallica** Lister l.c. Plasmodium watery-white. Sporangia solitary or clustered, globose, sessile on a narrow base, 0.5 to 1 mm. diam., sometimes forming straight or curved plasmodiocarps, pearl-grey or copper-coloured, shining, iridescent; sporangium-wall membranous, single, glaucous or yellowish, translucent. Capillitium a profuse coil of very long elastic flexuose solid grey or yellowish threads, 0.5 to 1  $\mu$  diam., increasing in some parts to 2  $\mu$ , scarcely branching, with few attachments to the sporangium-wall or almost free, marked with a very lax spiral band of minute spinules. Spores in mass pale pinkish-grey, becoming yellowish-buff in age, when magnified nearly colourless, minutely warted, 10 to 13  $\mu$  diam.—Meylan in Bull. Soc. Vaud. Sci. Nat., xlv. 56. *M. pictoviana* Moore in Proc. Nova Scotia Inst. Sci., xii. 96 (1910)? *Physarum metallicum* Berk. & Br. in Mag. Zool. Bot., i. 49 (1838). *Cornuvia metallica* Rost. Mon., App. p. 35. *Perichaena plasmodiocarpa* Blytt in Bidr. K. Norg., Sop. iii. 10 (1892).

Pl. 196.—*a*, two forms of sporangia on wood; *b*, sporangium on leaf; *c*, capillitium with fragment of sporangium-wall and spores; *d*, capillitium and spore; (England).

The sporangia formed on leaves are usually solitary and spherical; those on wood are often clustered, and either subglobose or in the form of short or elongated plasmodiocarps. The beautiful pearly- or pinkish-grey of the freshly gathered spores fades to dull ochraceous-yellow after the specimen has been kept for some time in the herbarium. If developed under unfavourable conditions, the capillitium often consists in part of stout irregular branching threads showing numerous attachments to the sporangium-wall; the sporangia then bear considerable resemblance to cold-weather forms of *Prototrichia metallica*, to which the present species is undoubtedly allied.

In Rostafinski's Monograph, and in the first edition of the present work, *Licea incarnata* Alb. & Schw. Consp. Fung., 109 (1805) (syn. *Perichaena incarnata* Fr. Syst. Myc., iii. 193) is placed as a synonym for *Lachnobolus congestus*; the description given by Albertini and Scheintz, however, of the flesh-coloured iridescent sporangia, hemispherical, oval, "sub-linear" or flexuose in shape, and with extremely fragile sporangium-walls, applies better to some forms of the present species; but in the absence of the type this determination must remain conjectural.

*Hab.* On dead leaves, especially on those of holly, and dead wood.—Batheaston, Somerset (B.M. 95); Lyme Regis (B.M. 1533); Salisbury

(B.M. 3148): Luton, Beds (B.M. 3149); Witley, Surrey (B.M. 3150); Epping Forest, Essex (B.M. 3151); Norfolk (B.M. 3152); Birmingham (B.M. 1535); Salop (B.M. 3153); Yorks (B.M. 3154); North Wales (B.M. 3155); Aberdeen (B.M. 3156); Norway (B.M. slide); Jura, Switzerland (B.M. 3157); Portugal (B.M. 3158); Japan (B.M. 3159); Chocorua, New Hants (B.M. 3160); Punta Arenas, Chili (B.M. 3200).

Genus 47. **DIANEMA** Rex in Proc. Acad. Nat. Sci. Phil., 1891, 397. Sporangia sessile, or forming plasmodiocarps; sporangium-wall membranous or cartilaginous; capillitium consisting of nearly straight slender threads, attached above and below to the sporangium-wall.

### KEY TO THE SPECIES OF *DIANEMA*.

A. Sporangium-wall translucent, membranous; spores free:—

Capillitium threads nearly simple, attached to the sporangium-wall by short branches. 1. *D. Harveyi*

Plasmodiocarps; capillitium threads attached by acuminate extremities to the sporangium-wall.

2. *D. depressum*

B. Plasmodiocarps with cartilaginous walls; spores clustered.

3. *D. corticatum*

1. **D. Harveyi** Rex l.c. Plasmodium? Sporangia solitary or in small clusters, sessile, subglobose, hemispherical or cushion-shaped, flattened above, 0.5 to 2 mm. diam., 0.35 to 1 mm. in height, sometimes elongated and bent into an irregular horse-shoe shape, dull red or gold-bronze shining with a metallic lustre; sporangium-wall membranous, thin, translucent, pale purplish or olivaceous, marked with the persistent ends of the capillitium when the rest of the threads have broken away. Capillitium of numerous slender, brownish-yellow threads, 1.5 to 2  $\mu$  diam., simple or sparingly branched and anastomosing, often dividing into slender branchlets at their origin or insertion, nearly parallel, straight or flexuose, running from the base to the upper wall of the sporangium. Spores in mass brick-red, dull pink or brownish-yellow, when magnified pale yellow, minutely warted, 8 to 10  $\mu$  diam.—Macbride N. Am. Slime-Moulds, 180; Torrend Fl. Myx., 84.

Pl. 191.—a. sporangia; b. capillitium showing attachment above and below to the sporangium-walls, with spores; c. spore; (Devon).

The specimen figured is taken from one of a series of gatherings made in a sheltered valley by the sea near Lyme Regis. They agree

with the type from Maine, U.S.A., in capillitium and spores, but the colour of the sporangia is dull brick-red instead of "gold bronze." By the light of these specimens, that in Broome's Collection (B.M. 94) marked "*Physarum metallicum*," is clearly the same species; it is in a fragile condition and as the capillitium breaks up when mounted the characters are difficult to recognise, but the numerous broken points of attachment to the base and upper wall of the sporangium, together with the minutely warted spores, leave no doubt of its identity. The date and locality are not given by Broome, but it is probable that it was gathered at Batheaston in 1869 or 1870, as it stands in his collection among other specimens correctly marked *Physarum metallicum* Berk and Br. (syn. *Margarita metallica*) gathered there at that date. *Dianema Harveyi* has appeared during a period of five years in the winter and early spring near Lyme Regis, always in small quantity, upon dead sticks of ash and elematis. It has been found repeatedly near Aberdeen, by the Rev. W. Cran, on the bark of ash and fir in winter. In a gathering made by him in January, 1911, the pulvinate sporangia contain abundant capillitium; the threads are rather stouter below than above, they anastomose and branch freely, and are marked with bead-like swellings.—M. Meylan has courteously sent us part of the type of his new genus *Lamprodermopsis*—*L. nivalis* (Bull. Soc. Vaud., xlv. 56 (1910)). The sessile, pulvinate sporangia were gathered on turf in the Jura Mountains at an elevation of about 4,000 feet, near melting snow. The specimen sent us agrees in all essential characters with the genus *Dianema*. It appears to be very closely allied to *D. Harveyi*, from which it differs only in the capillitium threads being rather stouter at the base where they radiate from the more central parts of the floor of the sporangium, while above the slender tips of the threads are easily detached from the sporangium-wall; the spores are greyish-pink in colour. M. Meylan writes that the sporangia are sometimes mounted on pale stalks, "0 to 1 mm. high." These characters can scarcely be regarded as of sufficient importance to constitute generic distinction, and it would seem preferable, if the distinguishing features prove constant, to place this interesting Alpine species next *D. Harveyi* under the name of *Dianema nivalis*.

*Hab.* On dead wood, and turf.—Lyme Regis, Dorset (B.M. 3161); Aberdeen (B.M. 3162); Maine (B.M. slide).

2. *D. depressum* Lister Mycetozoa, 204 (1894). Plasmodium white, rarely rosy red. Sporangia solitary or clustered, forming sessile pulvinate depressed plasmodiocarps, 2 to 10 mm. wide, about 0.3 mm. thick, shining violet when immature, glossy and grey-brown when mature; sporangium-wall membranous, smooth, translucent, yellowish- or lilac-grey, marked on the inner side with the persistent ends of the capillitium when the rest of the threads have fallen away. Capillitium profuse, consisting of pale yellowish-grey straight rigid slender threads, 0.5 to 2  $\mu$  thick, forking at an acute angle, connected with each other at the opposite ends, or fasciculate, without free branches, minutely papillose on one side, attached above and below to the sporangium-wall by the suddenly acuminate extremities.

Spores in mass lilac-grey or drab, when magnified pale yellowish-grey, closely reticulated over the greater part of the surface with raised bands, forming a border  $0.5$  to  $1\ \mu$  broad, the remaining part marked with broken or very loose reticulation,  $6$  to  $9\ \mu$  diam.—*Cornuvia depressa* Lister in Journ. Bot., xxix. 264, t. 311, fig. 2 (1891).

Pl. 190.—*a.* sporangium; *b.* spores and capillitium showing attachment of the threads to the base and upper wall of the sporangium *c.* capillitium and spores; (England).

This species was first described under the name of *Cornuvia depressa*, on account of its affinity with *Margarita metallica*, which was formerly included in the genus *Cornuvia*. Dr. Rex having since established the genus *Dianema* for the closely allied American species, it is here adopted as in every way the more appropriate position for this species. The sporangium-wall is usually single, but sometimes has an outer purplish granular layer clothing the membranous layer.

*Hab.* On dead wood and sticks.—Batheaston, Somerset (B.M. 2 to 5); Rudloe, Wilts (B.M. 19); Lyne Regis, Dorset (B.M. 1536); Alresford, Hants (B.M. 3163); Sutton Coldfield, Warwick (B.M. 3164); Bungay, Norfolk (B.M. 3165); Tansterne, Yorks (B.M. 3166); Sweden (B.M. 3167); Portugal (B.M. 3168).

**3. *D. corticatum*** Lister Mycetozaa, 205 (1894). Plasmodium pink. Sporangia either hemispherical,  $1\text{ mm.}$  diam., or more often forming elongated, ring-shaped or net-like plasmodiocarps  $3$  to  $30\text{ mm.}$  long, shining or opaque, chestnut- or purple-brown; sporangium-wall ochraceous-olive, composed of two layers, the outer cartilaginous, densely granular, the inner membranous. Capillitium somewhat sparse, consisting of simple or acutely branching slender pale brown threads,  $0.5$  to  $1.5\ \mu$ . diam., often showing distant bead-like thickenings, elsewhere either nearly smooth or marked with a single prominent spiral band or for a short distance with three spiral bands; the threads are attached above and below by very slender extremities to the sporangium-wall. Spores brownish-pink in mass, nearly colourless when highly magnified, subelliptical, adhering in clusters of  $4$  to  $6$ , minutely warted on the outer side,  $10$  to  $12\ \mu \times 8$  to  $9\ \mu$  diam.—Torrend Fl. Myx., 84.

Pl. 193.—*a.* plasmodiocarp; *b.* capillitium attached to fragment of sporangium-wall, and clustered spores; *c.* capillitium and spores; (Norway).

This species was found first on rotten planks at Sande, Norway, September, 1894, associated with *Licea flexuosa*, to which it bears a superficial resemblance; *D. corticatum* may however be distinguished in the field by the more lilac or pinkish colour of the spores. It has since been obtained from Northumberland, Scotland, Sweden, Austria and the Jura Mountains. *Dianema corticatum* holds an intermediate position between the genera *Dianema* and *Prototrichia*,

the capillitium having the general features of the former, but exhibiting in some sporangia something of the spiral bands characteristic of the latter genus. It differs from the species hitherto comprised in both genera in the more substantial sporangium-wall and in the clustered spores.

*Hab.* On dead wood.—Alnwick, Northumberland (B.M. 3169); Drumnadrochit, Inverness (B.M. 3170); Rhynie, Aberdeen (B.M. 1766); Norway (B.M. 1538); Sweden (B.M. 3171); Austria (B.M. 3172); Mont Tendre, Jura Mountains (B.M. slide).

Genus 48.—**PROTOTRICHIA** Rostafinski Mon., App. p. 38 (1876). Sporangia sessile, rarely stalked; capillitium threads rising from the base of the sporangium as stout strands marked with spiral thickenings, dividing above into pencils of slender branches attached at the tips to the upper part of the sporangium-wall.

1. **P. metallica** Mass. in Journ. R. Micr. Soc., 1889, 350. Plasmodium white. Sporangia crowded or scattered, subglobose, 0.5 to 1 mm. diam., sessile on a broad base, rarely stalked or forming plasmodiocarps, brown or copper-coloured, shining iridescent; sporangium-wall a substantial pale pinkish-brown or glaucous smooth translucent membrane, sprinkled on the inner side with the slender persistent ends of the broken capillitium threads. Stalk cylindrical, 0.1 to 0.4 mm. long, 0.15 mm. thick, solid, yellowish-brown. Capillitium rising from the base of the sporangium in the form of numerous red- or olive-brown stout solid threads marked with two to four spiral bands, branching repeatedly above to form a pencil of more slender threads attached at their extremities to the sporangium-wall. Spores pink or pale pinkish-brown, minutely warted, 9 to 11  $\mu$  diam.—Mass. Mon., 127. *Trichia metallica* Berk. in Hooker Fl. Tasm., pt. 2, 268 (1860). *T. flagellifera* Berk. & Br. in Ann. Mag. Nat. Hist., ser. 3, xviii. 56 (1866). *Prototrichia flagellifera* Rost. Mon., App. p. 38 (1876); Mass. l.c.; Lister Mycetozoa, 206; Macbride N. Am. Slime-Moulds, 199. *P. elegantula* Rost. l.c., 39, fig. 246. *P. cuprea* Mass. in Journ. R. Micr. Soc., 1889, 351; Mass. Mon., 129. *P. chamaeleontina* Mass. l.c., 130, in part.

Pl. 195.—*a.* sporangia; *b.* stalked sporangium; *c.* capillitium with fragment of sporangium-wall and spores; *d.* irregular capillitium with faint spirals; *e.* spore; (England).

*P. metallica* has appeared abundantly in the neighbourhood of Lyme Regis in a larch plantation for several years, in the autumn and winter, on dead brambles and sticks. It is subject to considerable variation from changes of temperature and weather. In the most perfect development the strands of the capillitium are deep red-brown, sharply marked

with regular and close spiral bands, dividing above into a brush of more slender straight threads; the spores are pale pinkish-brown, and distinctly warted. Where the development has been checked by cold or dry weather, the threads are pale olive and divide into irregular or lax branches and show indistinct spiral markings; or the spiral character may be wanting or replaced by broad or narrow rings; associated with this form the spores are paler, and faintly warted or nearly smooth. In cultivations where the plasmodium has been injured in conveying it indoors, the capillitium often forms very irregularly, the threads anastomosing with broad and flat expansions and showing no appearance of spirals. Gatherings of this form were also obtained by Mr. Camm from Smethwick, Stafford, after cold weather, and are described by Massee as a distinct species *Prototrichia chamaeleontina*.\* Little now remains of the type of *Trichia metallica* Berk. from Tasmania (K. 1741); but the specimen is referred to *Prototrichia flagellifera* by Rostafinski, who saw it in good condition, and by the rule of priority Berkeley's earlier specific name must be retained. The type of *Trichia flagellifer* Berk. from Badminton (B.M. 333) is the form of the present species with olivaceous capillitium marked with faint spirals, and having nearly smooth spores. The type of *P. elegantula* Rost., from Sweden (K. 1743), is a more perfect development with the spirals well marked and with distinctly warted spores. *P. cuprea* Mass., from Scarborough and Carlisle (K. 1744, 1745), is a similar form with minutely warted spores. The large and varied gatherings from Lyme Regis show that the specimens quoted above represent one species whose diverging forms are too inconstant to be defined even as varieties. *P. metallica* is said to be not uncommon in the forests of the western States of America.

*Hab.* On dead sticks, bark, etc.—Batheaston, Somerset (B.M. 324); Badminton, Gloucester (B.M. 333); Lyme Regis, Dorset (B.M. 1539); Smethwick, Stafford (B.M. 3173); Luton, Beds (B.M. 3174); Hedon, Yorks (B.M. 3176); Benthall, Salop (B.M. 3177); Alnwick, Northumberland (B.M. 3178); Berwick (Phillips Herb.); Aberdeenshire (B.M. 3179); Letterfrack, Ireland (B.M. 3175); Holstein (B.M. 3180); Norway (Christiania Herb.); Sweden (K. 1743); Jura Mountains (B.M. 3181); Tasmania (K. 1741); Washington State, U.S.A. (B.M. 3182).

Genus 49. **LISTERELLA** Jahn in Ber. Deutsch. Bot. Gesellsch., xxiv. 540 (1906). Sporangia minute, hemispherical brownish-black, dehiscing in lobes; sporangium-wall membranous; capillitium of very slender threads marked with moniliform thickenings, attached to the sporangium-wall; spores grey.

1. **L. paradoxa** Jahn l.c., 538, t. xxii, figs. 1-7. Plasmodium? Sporangia scattered, sessile, hemispherical or pulvinate on an expanded base, 0.2 to 0.3 mm. diam., dull blackish-brown, marked with shining ridges corresponding with the lines of dehiscence; sporangium-wall membranous,

\* It is unfortunate that *Cornuvia metallica* Rost. (= *Margarita metallica* Lister) should have been cited by Mr. Massee as a synonym for *Prototrichia chamaeleontina*.

purplish-brown, clothed externally with dark granular refuse-matter except along the margins of the four to six lobes of dehiscence. Capillitium scanty, consisting of slender flexuose pale purplish-brown threads,  $0.5\ \mu$  diam., marked at intervals of 1 to  $2\ \mu$  with bead-like thickenings, attached below and perhaps above also to the sporangium-wall. Spores in mass blackish-brown; when magnified faintly spinulose, 7 to  $8\ \mu$  diam., pale brownish-grey with a paler patch of dehiscence on one side.

Pl. 191.—*d. e.* sporangia; *f.* capillitium and spores with fragment of sporangium-wall: (North Germany).

This minute and inconspicuous species has been found scattered over the stems of "reindeer moss" (*Cladonia rangiferina*) by Herr O. Jaap near both Hamburg and Triglitz in North Germany, and by Herr G. Lindau near Berlin. In size and external appearance *Listerella parvuloxa* resembles *Licea minima*, but as Dr. Jahn points out, the presence of the capillitium completely separates the genus from the *Liceaceae*; he suggests that it should be the type of a new family, the *Listerellaceae*. It is placed here provisionally among the *Margaritaceae*, but its true position is at present uncertain. It may perhaps be allied to *Dianema*, but is distinguished by the regular moniliform markings of the capillitium, and by the dusky colour of the spores.

*Hab.* On stems of *Cladonia*. Triglitz, Holstein (B.M. 3183).

## A DOUBTFUL MYCETOZOON.

**Hymenobolus** Zukal in Oester. Bot. Zeitschr., xliii. 73 (1893). Sporangia solitary, sessile, brownish-grey. Sporangium-wall single, without lime. Capillitium very scanty? or none. Spores globose, having the spore-wall thinner on one side. Plasmodium parasitic on lichens and algae.

**H. parasiticus** Zukal l.c. Plasmodium rosy-red. Sporangia scattered, sessile, subglobose, or hemispherical and depressed, often irregular in outline,  $0.05$  to  $0.2$  mm. diam., brownish-grey, opaque or glossy, dehiscing irregularly or by a well-defined lid; sporangium-wall membranous, pale-purplish, minutely papillose on the inner surface, usually invested with a thick layer of refuse-matter in the lower part. Capillitium possibly of scanty hyalines paringly-branched threads,  $0.5\ \mu$  diam., arising from the sporangium-wall? or entirely absent. Spores smooth, brown, subglobose, 13 to  $16\ \mu$  diam., the spore-wall paler and thinner on one side; the contents of the spore consist in part of rosy granules.

This minute species is fully described by Zukal, who succeeded in cultivating the plasmodia on fragments of willow-bark. Although closely allied to the true *Mycetozoa* it differs from them in the two following characters: the amoeboid swarm-cells do not pass through a



flagellate stage, and the plasmodium does not exhibit the characteristic rhythmic circulation of granular protoplasm, but instead shows slow irregular movements. The habit of the plasmodium also is remarkable. Instead of spreading in branching veins, each plasmodium forms a small, nearly stationary mass, that feeds on the lichen or algaelying beneath it, and into which it gradually penetrates. In dry weather each plasmodium contracts to form a spherical rose-coloured macrocyst 0.1 to 0.2 mm. diam., and then resembles the perithecium of a *Nectria*. The Rev. W. Cran has repeatedly found the macrocysts on lichens and algae growing on elder and ash bark near Aberdeen; he has lately gathered the mature sporangia also. The macrocysts that he kindly sent us soon revived on being moistened, and formed plasmodia that moved about slowly for some days in a moist chamber. There is no trace of capillitium in the sporangia we have examined, and it seems possible that the threads Zukal described as capillitium may have been the hyphae of some minute mould.

*Hab.* On lichens and algae on bark.—Near Aberdeen (B.M. 3198); Austria (B.M. 1968A).

## Additional List of Synonyms.

- AETHALIUM MELAEENUM Chev. in Fung. et Byss. Illustr., fasc. i. (1837) no. 32 = *Lindbladia effusa* Rost.  
 A. RUFUM Wallr. Fl. Crypt. Germ., no. 2097 = *Fuligo septica* Gmel.  
 A. VIOLACEUM Spreng. Syst. Orb. Veg., iv. no. 533 = *Fuligo septica* Gmel.  
 AMPHISPORIUM VERSICOLOR Link in Mag. Ges. Nat. Fr. Berl., vii. Diss. 2, 41 = *Didymium difforme* Duby.  
 ARCYRIA COCCINEA Duby Bot. Gall., ii. 857 = *A. ferruginea* Saut. ?  
 A. CYLINDRICA Schum. Enum. Pl. Saell., ii. 215 = *A. denudata* Sheldon.  
 A. FLEXUOSA Rabenh. Deutschl. Krypt. Fl., no. 2158 = *A. Oerstedtii* ?  
 A. LEPRIEURII Mont. in Ann. Sci. Nat., Bot., ser. 4, iii. 141 = *A. cinerea* Pers.  
 CHONDRIODERMA LEPTOTRICHUM Racib. in Rozpr. Mat.-Przyr. Acad. Krak., xii. 75 = *Didymium squamulosum* Fr. ?  
 C. PUIGGARI Speg. in Bot. Acad. Nac. Cienc. Cordoba, xi. 475 (1889) = *Diderma simplex* Lister ?  
 CIONIUM COMPLANATUM Link ex Wallr. Fl. Crypt. Germ., no. 2176 = *Didymium crustaceum* Fr. ?  
 C. FARINACEUM Link Handb., iii. 410 = *Didymium melanospermum* Macbr.  
 C. FLORIFORME Spreng. Syst. Orb. Veg., iv. 529 = *Diderma floriforme* Pers.  
 C. GLOBOSUM Spreng. l.c. = *Diderma globosum* Pers.  
 C. LEPIDOTUM Spreng. l.c. = *Diderma floriforme* Pers.  
 C. LOBATUM Spreng. l.c. = *Didymium melanospermum* Macbr.  
 C. SQUAMULOSUM Spreng. l.c., 628 = *Didymium squamulosum* Fr.  
 C. TESTACEUM Spreng. l.c., 529 = *Diderma testaceum* Pers.

- C. TIGRINUM Link l.c., 416 = *Lepidoderma tigrinum* Rost.  
 C. UMBILICATUM Spreng. l.c. = *Diderma radiatum* Lister.  
 COMATRICHIA ALBA Schuler in Just Bot. Jahresb., 1877, 155 = *Arcyria cinerea* Pers.  
 CRATERIUM NUTANS Fr. Syst. Myc., iii. 151 = *C. minutum* Fr.  
 C. PENDULUM Fr. ex Weinm. Hymeno-Gastero-myc., 597 = *C. leucocephalum* Ditm. ?  
 CRIBRARIA (DICTYDIUM) TRICHIODES Chev. Fl. Par., 327 = *Dictydium cancellatum* Macbr.  
 CYTIDIUM CITRINUM Morg. Myx. Miami Valley, 81 = *Physarum citrinum* Schum.  
 C. GLOBULIFERUM Morg. l.c., 82 = *Physarum globuliferum* Pers.  
 C. PENETRALE Morg. l.c., 83 = *Physarum penetrale* Røx.  
 C. PULCHERRIMUM Morg. l.c., 80 = *Physarum pulcherrimum* Berk. & Rav.  
 CUPULARIA LEUCOCEPHALA Link Handb., iii. 421 = *Craterium leucocephalum* Ditm.  
 CYATHUS CINEREUS Purt. Brit. Pl. Midl. Fl., iii. 309, t. 35 = *Craterium leucocephalum* Ditm.  
 C. MINUTUS Hoffm. Veg. Crypt. 6, t. ii., f. 2 = *Craterium minutum* Fr.  
 DIACHAEA FULGENS Fr. ex Weinm. l.c., 611 = *Diachea subsessilis* Peck ?  
 DIDERMA CHALYBEUM Weinm. l.c., 592 = *Didymium difforme* Duby var. *comatum* ?  
 D. CONTORTUM Fockel Symb. Myc., no. 341 (1869) = *Physarum sinuosum* Weinm. ex Fries.  
 D. NEESI Corda Icon., ii. 23 = *Didymium difforme* Duby.  
 D. OBLONGUM Schum. l.c., 197 = *Physarum didermoides* Rost.  
 D. PAPAVERINUM Wallr. Fl. Crypt. Germ., 375 = *Badhamia capsulifera* Berk. ?  
 D. RAMOSUM Fr. Syst. Myc., iii. 105 = *Leocarpus fragilis* Rost.  
 DIDYMIUM CONGESTUM Berk. & Br. in Ann. and Mag. Nat. Hist., ser. 2., v. 365 = *Physarum didermoides* Rost.  
 D. FULVIPES Fr. Symb. Gast., 24 = *Physarum psittacinum* Ditm. ?  
 D. PORPHYROPUS Dur. et Mont. in Expl. Scient. de l'Algérie, 409 = *Didymium nigripes* Fr.  
 D. TERRESTRE Fr. ex Weinm. l.c., 574 = *Physarum nutans* Pers. subsp. *leucocephalum*.  
 FULGIA ENCAUSTICA Chev. Fl. Par., ed. 2, 347 = immature *Lamproderma columbinum* Rost.  
 FULIGO CARNEA Schum. l.c., 194 = *F. septica* Gmel. ?  
 F. CEREBRINA Brondeau in Mém. Soc. Linn. Paris, iii. 74 = *F. septica* Gmel.  
 HEMITRICHIA BUCKNALLI Mass. in Grev., xviii. 27 = *Trichia scabra* Rost.  
 LAMPRODERMA INCONSPICUUM Racib. in Hedw., xxxv. 208 = *L. arcyrionema* Rost. ?  
 L. TATRICUM Racib. l.c., xxviii. 117 = *L. violaceum* Rost. ?  
 LEANGIUM ATROVIRENS Fr. Stirp. Femsj., 83 } = *Leocarpus fragilis* Rost.  
 L. VERNICOSUM Fr. l.c. }  
 L. RUBIGINOSUM Fr. l.c. = *Physarum rubiginosum* Fr.  
 LEOCARPUS CYANESCENS Fr. Summ. Veg. Scand., 450 = *Didymium difforme* Duby.  
 L. DEPLANATUS Fr. l.c. = *Diderma niveum* Macbr. var. *deplanatum*.  
 LICEA ANTARCTICA Speg. in Bol. Acad. Nac. Cienc. Cord. Arg., xi. 5 = *Perichaena corticalis* Rost. ?  
 L. CLAVATA Schrad. Nov. Pl. Gen., 18 = *Tubifera ferruginosa* Gmel.

- L. NITENS Schwein. in Trans. Amer. Phil. Soc., n. ser., iv. 259 = *Perichaena corticalis* Rost. ?
- L. STIPITATA DC. Fl. Fr., ii. 101 = *Didymium squamulosum* Fr.
- L. TUBULINA Schrad. l.c., 16 = *Tubifera ferruginosa* Gmel.
- LIGNIDIUM RENIFORME Fr. Symb. Gast., 10 = *Fuligo muscorum* Alb. & Schwein. ?
- LYCOGALA INCARNATUM Swartz in Handl. K. Svenska Vet. Acad. 1815, 112 (syn. *Licea incarnata* Alb. & Schw.) = *Margarita metallica* Lister ?
- L. LENTICULARE Dur. et Mont. l.c., 401 = *Dictydiaethalium plumbeum* Rost.
- L. PLATENSE Speg. in Anal. Mus. Nac. Buenos Aires, vi. 203 = *Lycogala epidendrum* Fr. ?
- L. PLUMBEUM Fr. Symb. Gast., ii. = *Lycogala epidendrum* Fr. ?
- L. REPLETUM Morgan in Journ. Cinc. Soc. Nat. Hist., xviii. 40 = *L. flavofuscum* Rost. ?
- LYCOPERDON BOMBACINUM Batsch Elench. Fung., 153 = *Hemitrichia Vesparium* Macbr. ? or *Trichia Botrytis* Pers.
- L. FAVACEUM Schrank Baier. Fl., ii. 667 = *Tubifera ferruginosa* Gmel.
- L. FLORIFORME Wither. Brit. Pl., ed. iv., vol. iv. 379 = *Diderma floriforme* Pers.
- L. LUTEUM Schrank l.c., ii. 629 = *Fuligo septica* Gmel.
- L. PARASITICUM Wither. l.c., 372 = *Leocarpus fragilis* Rost.
- L. PINEUM Batsch Elench. Fung., 155 = *Lycogala epidendrum* Fr. ?
- L. RUFUM Dickson Pl. Crypt. Brit., i. 25 = possibly *Arcyria denudata* Sheldon.
- L. VARIOLOSUM Huds. Fl. Angl., 645 = *Lycogala epidendrum* Fr.
- MUCOR ARANEOSUS Jacq. Misc., ii. 376, t. 20 = *Stemonitis fusca* Roth ?
- M. LYCOGALUS Bolton Hist. Fung., iii., 133, t. 133, f. 2 = *Reticularia Lycoperdon* Bull.
- M. LYCOPODIOIDES Scop. in Ann. Hist. Nat., iv. 151, t. 1, f. 11 = *Perichaena corticalis* Rost. ?
- M. MINIATUS Jacq. Fl. Austr., iii. 54, t. 299 = young sporangia of *Trichia decipiens* Macbr.
- OPHIOTHECA NITENS Mass. Mon., 133 = *Perichaena depressa* Libert.
- PERICHAENA ANNULIFERA Boudier in Bull. Soc. Myc. Fr., xviii. 144, t. 8, f. 3 = *Trichia scabra* Rost. ?
- PHYSARUM BOTRYOIDES var. a HYALINUM Fr. Stirp. Femsj. = *Badhamia capsulifera* Berk. ?
- P. CRUSTIFORME Speg. l.c., vi. 200 = *Diderma effusum* Morgan ?
- P. DIFFORME Link in Mag. Ges. Nat. Fr. Berl., iii. 27 = *Didymium difforme* Duby.
- P. GLOBOSUM Schum. l.c., 204 = *P. nutans* Pers.
- P. LICEA Fr. Syst. Myc., iii. 143 = *Licea pusilla* Schrad.
- P. LICEOIDES Duby Bot. Gall., ii. 461 = *Didymium squamulosum* Fr. ?
- P. LUTEO-ALBUM Schum. l.c., 200 = *Perichaena corticalis* Rost.
- P. PEDUNCULATUM l.c., 206 = *Craterium minutum* Fr.
- P. TUCUMANENSE Speg. in Rev. Agr. Veter. la Plata, 1896, 237 = *P. melleum* Mass. ?
- POLYSCHISMIUM TREVELYANI Corda Icon., v. 20 = *Diderma Trevelyani* Fr.
- RETICULARIA ANGULATA Pers. in Gmel. Syst. Nat., 1472 = *Didymium difforme* Duby ?
- R. CARNEA Fr. Syst. Myc., iii. 91 = *Fuligo septica* Gmel.
- R. CONTORTA Poiret in Lam. Encycl., vi. 182 = *Diderma hemisphericum* Hornem. ?

- R. FLORIFORMIS Poiret l.c. = *Diderma floriforme* Pers.  
 R. FRAGILIS Poiret l.c., 183 = *Leocarpus fragilis* Rost.  
 R. GLOBOSA Poiret l.c., 182 = *Diderma globosum* Pers.  
 R. MAXIMA Corda Icon., vi. 14, t. ii., f. 35 = *Lindbladia effusa* Rost.  
 R. OCHRACEA Poiret l.c. = *Diderma ochraceum* Hoffm.  
 R. OVATA Wither. l.c., 463 = *Fuligo septica* Gmel. ?  
 R. PUSILLA Fr. Syst. Orb. Veg., i. 147 = *Didymium difforme* Duby.  
 R. RUFA Schwein. in Trans. Amer. Phil. Soc., n.s. iv., 261 = *Fuligo septica* Gmel.  
 R. SCHMITZII Debey in Verh. Nat. Hist. Ver. Preuss. Rheinl., ii, f. 1-4 = *Badhamia panicea* Rost. ?  
 R. SEPTICA Wither. l.c., 463 (1801) = *Fuligo septica* Gmel.  
 R. STRONGYLUM Schwein. Syn. Fung. Carol., 35 = *Amaurochaete fuliginosa* Macbr.  
 R. UMBILICATA Poiret l.c. ? = *Diderma radiatum* Lister.  
 R. VAPORARIA Chev. Fl. Par., i. 342 = *Fuligo septica* Gmel.  
 SPHAEROCARPUS COCCINEUS Bull. Champ., 126, t. 368, f. i. = *Arcyria ferruginea* Saut. ?  
 S. FICOIDES Bull. l.c., 129, t. 417, f. 2 = *Trichia Botrytis* Pers. ?  
 S. PIRIFORMIS Bull. l.c., 129, t. 417, fig. 2 = *Trichia decipiens* Macbr. ?  
 S. SEMITRICHIOIDES Bull. l.c., 125, t. 387 = *Cribraria aurantiaca* Schrad.  
 S. TRICHIOIDES Bull. l.c., 124, t. 387, fig. 2 = *Dictydium cancellatum* Macbr. ?  
 S. TURBINATUS Bull. l.c., 132, t. 484, f. 1 = *Craterium minutum* Fr. ?  
 SPUMARIA RAMOSA Schum. l.c., 195 = *Leocarpus fragilis* Rost.  
 STEMONITIS COCCINEA Gmel. Syst. Nat., 1468 = *Arcyria ferruginea* Saut. ?  
 S. CYATHIFORMIS Schrank l.c., 19 = *Craterium leucocephalum* Ditm. ?  
 S. DECIPiens T. F. L. Nees in Act. Phys. Med. Acad. Carolo-Leop., xvi. 95 = *S. herbatica* Peck ?  
 S. DENUDATA Relhan Fl. Cantabr., ed. 3, 574 (1820) = *Arcyria denudata* Sheldon.  
 S. FLAVESCENS Schrank l.c. (1790), 19 = *Trichia decipiens* Macbr. ?  
 S. FLORIFORMIS Gmel. Syst. Nat., 1469 = *Diderma floriforme* Pers.  
 S. GRISEA Opiz in Lotos 1855, 215 = *Arcyria cinerea* Pers.  
 S. LUMBRICALIS Gmel. Syst. Nat., 1470 = *Hemitrichia Serpula* Rost.  
 S. PLATENSIS Speg. l.c., vi. 202 = *Comatricha typhoides* Rost. ?  
 S. SEMITRICHIOIDES Gmel. Syst. Nat. 1468 = *Cribraria aurantiaca* Schrad. ?  
 S. TRICHIA Roth l.c., i. 549 = *Arcyria incarnata* Pers. ?  
 S. VESICULOSA Gmel. Syst. Nat., 1470 = *Trichia varia* Pers. ?  
 S. VESPARIA Gmel. l.c. = *Hemitrichia Vesparium* Macbr.  
 S. VIOLACEA Roth Fl. Germ., i. 548 = *Physarum nutans* Pers. ?  
 STRONGYLUM ATRUM Swartz in Handl. K. Svenska Vet. Acad. 1815, 110 = *Amaurochaete fuliginosa* Macbr.  
 S. FULIGINOIDES Ditm. in Schrad. Neu. Bot. Journ., iii. 3 = *Reticularia Lycoperdon* Bull.  
 TILMADOCHÉ SOLUTA Fr. Summ. Veg. Scand., 454 = *Physarum nutans* Pers.  
 TRICHIA ALATA Trentep. in Roth Catal. Bot., 228 = *Physarum nutans* Pers. ?  
 T. ALBA DC. Fl. Fr., ii. 202 = *Physarum nutans* Pers. ?  
 T. ANOMALA Karsten in Not. Saellsk. Faun. Fl. Fenn., ix. 354 = *T. scabra* Rost. ?  
 T. ANTIADES DC. l.c., 252 = *Diderma floriforme* Pers. ?  
 T. ARGILLACEA Poiret in Lam. Encycl., viii. 55 = *Cribraria argillacea* Pers.

- T. CERNUA Poiret l.c., 54=*Dictydium cancellatum* Macbr.  
 T. COCCINEA DC. Fl. Fr., no. 688=*Arcyria ferruginea* Saut. ?  
 T. COCCINEA Poiret l.c., 55=*Dictydium cancellatum* Macbr. ?  
 T. COLUMBINA Poiret l.c., 52=*Lamproderma columbinum* Rost.  
 T. DEPRESSA Trentep. l.c., 231=*Didymium melanospermum* Macbr.  
 T. FRAGIFORMIS Wither. Brit. Pl., 2. iii, 393=*Hemitrichia Vesparium* Macbr.  
 T. FULVA Wither. l.c., iv. 391=*Arcyria ferruginea* Saut. ?  
 T. GLOBOSA Vill. Fl. Dauph., 1061=*Didymium melanospermum* Macbr.  
 T. GLOBULIFERA DC. l.c., 253=*Physarum globuliferum* Pers.  
 T. HEMISPHAERICA Trentep. l.c., 228=*Physarum nutans* Pers. ?  
 T. INTRICATA Poiret l.c., 56=*Cribraria intricata* Schrad.  
 T. MACROCARPA Poiret l.c., 55=*Cribraria macrocarpa* Schrad.  
 T. MICROCARPA Poiret l.c., 54=*Cribraria microcarpa* Pers.  
 T. MUCORIFORMIS Schum. Enum. Pl. Saell., ii. 211=*Comatriza nigra* Schroeter.  
 T. NOTATA Schum. l.c.=young state of *Enerthenema papillata* Rost.  
 T. NUDA Wither. l.c., ed. 2, iii. 477=*Stemonitis fusca* Roth.  
 T. RUGOSA Trentep. l.c., 228=*Didymium squamulosum* Fr. ?  
 T. RUFA Wither. l.c., ed. 2, iii. 478=*Arcyria denudata* Sheldon.  
 T. RUFESCENS Poiret l.c., 55=*Cribraria rufa* Rost.  
 T. SEMICANCELLATA DC. Fl. Fr., 255=*Cribraria aurantiaca* Schrad.  
 T. SPHAERICA Trentep. l.c., 230=*Didymium squamulosum* Fr.  
 T. SPLENDENS Poiret l.c., 55=*Cribraria splendens* Schrad.  
 T. SQAMULOSA Poiret l.c., 53=*Lepidoderma tigrinum* Rost.  
 T. TIGRINA Poiret l.c.=*Lepidoderma tigrinum* Rost.  
 T. TURBINATA Wither. l.c., iv. 480 (1792)=*T. varia* Pers. ?  
 T. VIOLACEA Hoffm. Veg. Crypt. Germ., 5, t. ii., f. 1=*Lamproderma columbinum* Rost. ?  
 TUBIFERA CYLINDRICA Gmel. Syst. Nat., 1472 } *Tubifera ferruginosa*  
 T. FRAGIFORMIS Gmel. l.c. } Gmel.  
 TUBULINA CIRCUMCISSA Poiret l.c., viii. 131=*Perichaena corticalis* Rost.  
 T. FRAGIFERA Poiret l.c., 130=*Tubifera ferruginosa* Gmel.  
 T. PEDICELLATA Poiret l.c., suppl. v. 373=*Didymium squamulosum* Fr.  
 T. PUSILLA Poiret l.c., 131=*Licea pusilla* Schrad.  
 T. VARIABILIS Poiret l.c., 131=*Licea flexuosa* Pers.
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# List of Species to be Discarded

on account of their either being imperfectly described  
or not belonging to the Mycetozoa.

- ARCYRIA CARNEA Wallr. Fl. Crypt. Germ., ii. 383, a fungus, *Stilbum* sp. ?  
A. DENUDATA Fr. Nov. Symb. Mycol., 135, 1851, doubtful; possibly  
*Arcyria incarnata* Pers.  
A. RAMULOSA Wigand in Pringsh. Jahrb. wissensch. Bot., iii. 43=  
*Trichia ramulosa* Rudolphi, q.v.  
A. VIRIDIS Zollinger in Flora, xxx. 33 (1847), apparently not one of the  
Mycetozoa.  
BADHAMIA CARNEA Oudemans in Nederl. Kruidk. Arch., ser. 2, 166, a  
fungus, *Tubercularia* sp. ?  
CIONIUM CAROLINENSE Spreng. Syst. Veg., iv. 529, a fungus, *Caulo-  
glossum transversarium* Fr., teste Fries.  
C. PHYSAROIDES Spreng. l.c.=*Leangium physaroides* Link, q.v.  
C. SENEGALENSE Spreng. l.c., a fungus, *Podaron calyptratus* Fr.,  
teste Fries.  
CLATHRUS RECUTITUS L. Sp. Pl., ed. 2, 1649, doubtful.  
CRATERIUM DIFFORME Fr. Stirp. Femsj., 83, undescribed.  
CRIBRARIA COCCINEA Pers. Syn., 190, description insufficient.  
C. ONYGENA Schum. Enum. Pl. Saell., ii. 218, a fungus, *Onygena  
faginea* Fr.  
C. VENOSA Pers. Syn., 191=*Dictydium venosum* Schrad., q.v.  
DICTYDIUM DIDERMOIDES Fr. Syst. Myc., iii. 165, doubtful.  
D. MICROPUS Fr. l.c., 167=*Sphacrocarpus trichioides* Bull., q.v.  
D. TRICHOIDES Fr. l.c., 166, doubtful.  
D. VENOSUM Schrad. Nov. Gen. Pl., ii., doubtful.  
DIDERMA ACUMINATUM Schum. l.c., 198, doubtful.  
D. RAMOSUM Pers. Syn. 166=*Reticularia stipitata* Bull., doubtful;  
probably a fungus.  
D. STIPITATUM Fr. Syst. Myc., iii. 104=*Reticularia stipitata*  
Bull., q.v.  
D. TRICHODES Fr. l.c., 108=*Didymium trichodes* Link, q.v.  
DIDYMIUM OSSICOLUM Patouill. in Bull. Soc. Myc. Fr. 1888, 91,  
doubtful.  
D. PARIETINUM Schrad. Nov. Pl. Gen., 24, a fungus, *Anixia trunci-  
gena* Fr.  
D. RAMOSUM Duby Bot. Gall., ed. 2. iii. 859=*Reticularia stipitata*  
Bull., q.v.  
D. TRICHODES Link in Mag. Ges. Nat. Fr. Berl., vii. 42, a fungus, *Pezi-  
a Lonicerae* Alb. & Schw., teste Rostafinski.  
LACHNOBOLUS CINEREUS Schwein. in Trans. Amer. Phil. Soc., n.s. iv.  
261, doubtful.  
LEANGIUM PHYSAROIDES Link l.c., iii. 26, doubtful.

- LICEA BADIA Fr. Syst. Myc., iii. 198, a fungus, perhaps one of the *Perisporiaceae*, teste Rostafinski.
- L. BERTEROANA Mont. Fl. Chil., viii. 20, probably a perisporiaceous fungus, teste Rostafinski.
- L. BICOLOR Pers. Syn., 195, a fungus, *Anixia truncigena* Fr.
- L. MACROSPORA Schum. l.c., 218, a fungus, *Polyangium umbrinum* Fr., teste Fries.
- L. PANNORUM Wallr. Fl. Crypt. Germ., no. 2105 = *Anixia truncigena* Fr.
- L. EPIPHYLLA Schwein. l.c., 258, description inadequate.
- L. STROBILINA Alb. & Schwein. Conspect. Fung., 10, a fungus, *Aecidium strobilinum* Reess.
- L. SUBEREA Fr. l.c. 198, a fungus, *Aecidium* sp.
- L. SULPHUREA Wallr. Fl. Crypt. Germ., 344, a fungus, *Anixia truncigena* Fr.
- LEANGIUM PHYSAROIDES Link l.c., iii. 26, doubtful.
- LYCOGALA ATRA Pers. Syn., 159, a fungus, *Apiosporium* sp., teste Fuckel.
- L. GLOBOSA Schrank Baier. Fl., ii. 638, a fungus,
- L. NIVEUM Hoffm. Veg. Crypt., ii. 9, t. 2, f. 4, is apparently *Lamproderma* sp., immature.
- L. PARIETINUM Fr. l.c., 83 = *Didymium parietinum* Schrad., q.v.
- LYCOPERDON FUSCUM Huds. Fl. Angl., ii. 645 (1778), a fungus.
- MUCOR VIOLACEUS Leers Fl. Herborn., 287, doubtful.
- PERICHAENA DECIPIENS Berk. & Br. in Ann. Mag. Nat. Hist., ser. 4, xvii. 140, a fungus, *Aecidium strobilinum* Reess.
- P. GREGATA Fautr. & Lamb. in Revue Mycol., xvi. 161 (1894), description insufficient.
- P. PHAEOSPERMA Karst. in Revue Mycol., ix. 11 (1887), description insufficient.
- P. PICEA Berk. & Br. l.c., a pyrenomycetous fungus.
- P. STROBILINA Fr. Symb. Gast., 11, a fungus, *Aecidium strobilinum* Reess.
- PHYSARUM OXYACANTHE Schum. l.c., 199, doubtful.
- RETICULARIA EPIXYLON Bull. Champ., 90, t. 472, f. 1, a fungus, *Dichosporium* sp., teste Fries.
- R. NIGRA Bull. l.c., 88. t. 380, f. 2, probably a fungus.
- R. RAMOSA Gmel. Syst. Nat., 1471 = *R. stipitata* Bull., q.v.
- R. SEGETUM Bull. l.c., 90 t. 472 f. 2, a fungus, *Ustilago carbo* Tul.
- R. STIPITATA Bull. l.c., 89 t. 380 f. 3, probably a fungus.
- ROSTAFINSKIA AUSTRALIS Spegaz. in Ann. Soc. Cient. Argent., x. 151, appears to be a fungus from the description.
- SPUMARIA FLAVA Schum. l.c., 195, doubtful.
- S. PALLIDA Schum. l.c., doubtful.
- STEMONITIS ALBA Schrank Baier. Fl., ii. 635, doubtful.
- S. CARNEA Schrank l.c., probably a mould.
- S. FILICINA Schrank l.c., 634, doubtful.
- S. FLUMINENSIS Spegaz. l.c., xii. 255, doubtful, evidently an ill-developed specimen.
- S. FULVA Gmel. Syst. Nat., 1468, doubtful.
- S. FURFURACEA Gmel. l.c., doubtful.
- S. GLOBULARIS Gmel. l.c., doubtful.
- S. GRANIFORMIS Gmel. l.c., doubtful.
- S. LILACINA Schrank l.c., 635, doubtful.
- S. NIVEA Gmel. l.c., 1467, doubtful.

- S. PURPUREA Schrank in Mag. Bot., ii. 25, a fungus, *Botrytis carnea* Schum., teste Streinz.  
S. PYRIFORMIS Roth Fl. Germ., i. 548, doubtful.  
S. SULPHUREA Roth l.c., a fungus, *Eurotium herbariorum* Link.  
S. VIOLACEA Roth l.c., doubtful.  
TRICHIA ANGULATA Schwein. l.c., 259, doubtful.  
T. ARCYRIAEFORMIS Schum. l.c., 206, doubtful.  
T. BADIA Fr. Stirp. Femsj., 83, undescribed.  
T. CRASSA Schum. l.c., 208, doubtful.  
T. DIFFORME Schwein. l.c., 259, doubtful.  
T. FURFURACEA Wither. l.c., 392, doubtful.  
T. LENTICULARIS Hoffm. Veg. Crypt., 1A. 16, t. 4, f. 3, doubtful.  
T. LICHENOIDES Sibth. Fl. Oxon., 405, possibly a lichen.  
T. MINIATA Schwein. l.c., doubtful.  
T. NIVEA Hoffm. l.c., 15 t. iv., f. 2, doubtful.  
T. OLIVACEA Wither. l.c., iv. 392, doubtful.  
T. PHYSAROIDES Schum. l.c., 210, doubtful.  
T. PUNCTULATA Schwein. l.c., 259, doubtful.  
T. RAMULOSA Rudolphi in Linnaea, iv., 119, probably a fungus.  
T. RECUTILA Wither. l.c., doubtful.  
T. RETICULATA DC. Fl. Fr., ii. 256, doubtful, possibly *Dictydium cancellatum* Macbr.  
T. RUFA Hoffm. l.c., 10, t. 2, f. 5, doubtful.  
T. SPHAEROCEPHALA Hoffm. l.c., ii. 15, t. iv., f. 2, doubtful.  
TUBULINA BICOLOR Poiret l.c. = *Liccia strobilina* Alb. & Schwein., q.v.
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# Glossary.

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- AETHALIUM** : A compound fructification formed by the union of many sporangia ; the walls of the inner sporangia are more or less imperfectly developed.
- CAPILLITIUM** : A system of simple or branched, solid or tubular threads, developed within the sporangium, and usually assisting in the dispersion of spores.
- CARTILAGINOUS** : A term applied to a stout, uniformly thickened membrane.
- COLUMELLA** : A supporting structure arising from the base of the sporangium and giving attachment to the capillitium ; it may be either convex, conical, clavate or cylindrical ; in stalked sporangia it is directly continuous with the stalk.
- CORTEX** : An outer covering investing the aethalium.
- CYTOPLASM** : The finely granular and hyaline portion of protoplasm.
- EFFUSED** : Flattened and irregularly extended.
- ELATERS** : Free tubular capillitium-threads marked with spiral bands, characteristic of the genera *Trichia* and *Oligonema*.
- EPISPORE** : The outer layer of the spore-wall.
- FUSIFORM** : Spindle-shaped.
- FLAGELLUM** : The whip-like organ of motion of a swarm-cell.
- HYALINE** : Glassy clear.
- HYALOPASM** : That part of the cytoplasm which is free from granules.
- HYPOTHALLUS** : A membrane or system of strands from which the sporangia arise.
- LACINIATE** : Jagged or torn.
- LIME-KNOTS** : Expansions in the threads of the capillitium containing granules of calcium-carbonate.
- MACROCYST** : The resting condition of a very young plasmodium, consisting of a mass of cytoplasm with nuclei, enclosed in a double wall.
- MICROCYST** : The resting condition of a swarm-cell, consisting of a small spherical mass of cytoplasm and a nucleus, enclosed by a hyaline wall.
- MURICATE** : Rough, with hooked spines.
- NODES** : In the genus *Cribraria*, the upper half at least of the sporangium wall persists as a network of slender threads, usually conspicuously enlarged or thickened at the points of junction or *nodes*.
- PLASMODIOCARP** : Sessile sporangia having a vein-like or irregular outline.
- PLASMODIC GRANULES** : Minute, strongly refracting, usually coloured granules, conspicuous in the walls of sporangia of the genera *Lindbladia*, *Cribraria*, and *Dictydium* ; they dissolve in acid, and are well preserved in Canada balsam.
- PLASMODIUM** : A mass of naked protoplasm formed by the union of swarm-cells, and exhibiting a rhythmic circulation.

PSEUDO-CAPILLITIUM : The name applied to the imperfectly developed walls of the component sporangia of an aethalium, that may resemble true capillitium.

PSEUDO-COLUMELLA : In the *Physaraceae*, a mass of lime-knots confluent in the centre of the sporangium, resembling a columella but remaining free from the stalk.

PULVINATE : Cushion-like.

PYRIFORM : Pear-shaped.

SCLEROTIUM : The resting condition of the plasmodium ; it is formed of numerous, closely compacted cysts, the "sclerotium cysts," each consisting of a mass of cytoplasm with ten to twenty nuclei, and enclosed by a wall of cellulose ; the dry horny sclerotium may retain its vitality for several years.

SPORANGIUM : A receptacle containing spores.

SPOROPHORE : A structure bearing spores on its surface (compare *Ceratiomyxa*).

SWARM-CELL : The protoplasmic body that emerges from the spore on germination ; it contains a nucleus and contracting vacuole ; at first it is amoeboid, later it becomes pear-shaped with the narrow end prolonged into a flagellum with which it swims in the water.

TERETE : Having a circular transverse section.

TURBINATE : Top-shaped.

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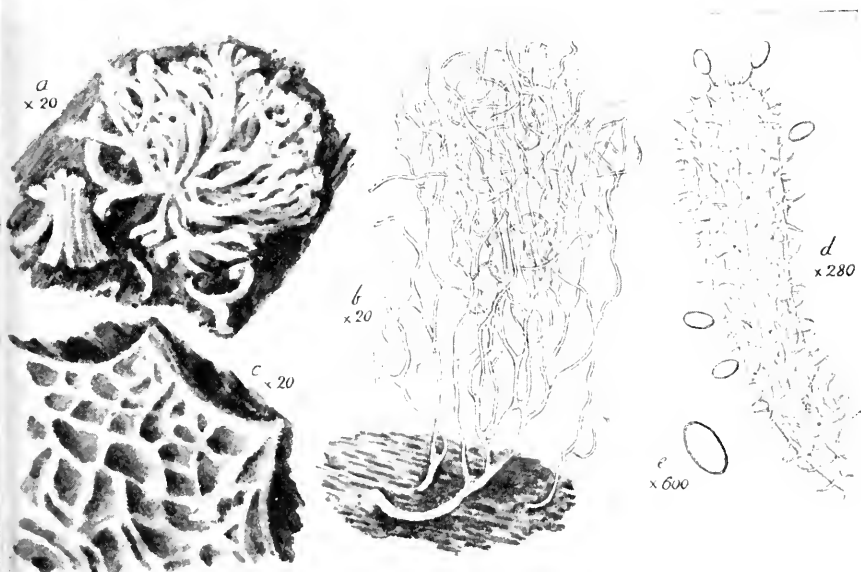
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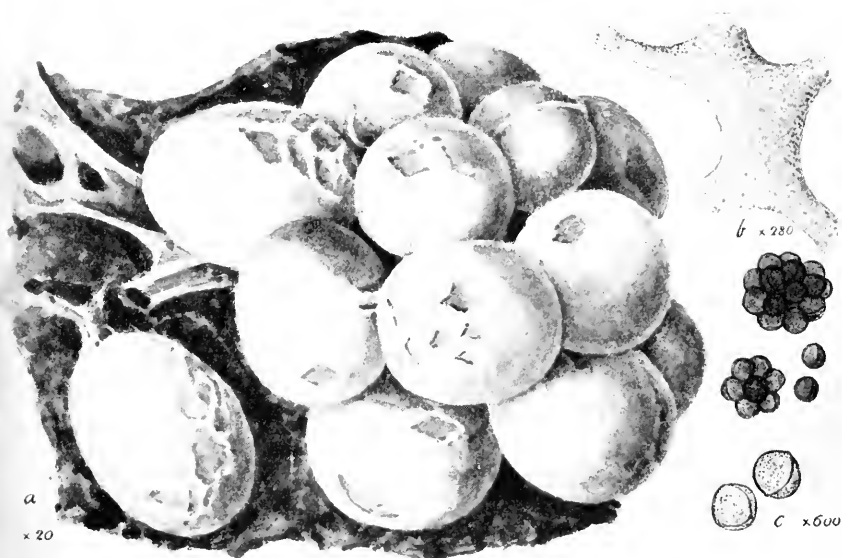


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LETTERPRESS AND COLOUR PRINTERS  
326 HIGH HOLBORN

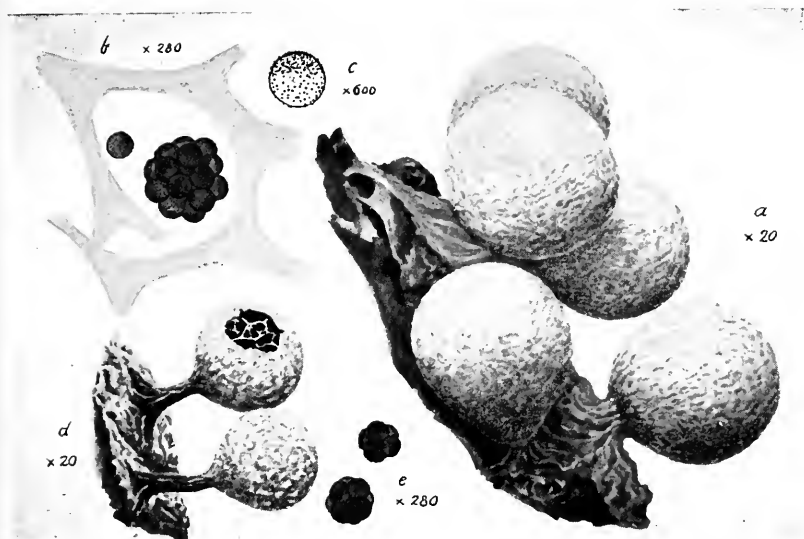


1. *CERATIOMYXA FRUTICULOSA* Macbride

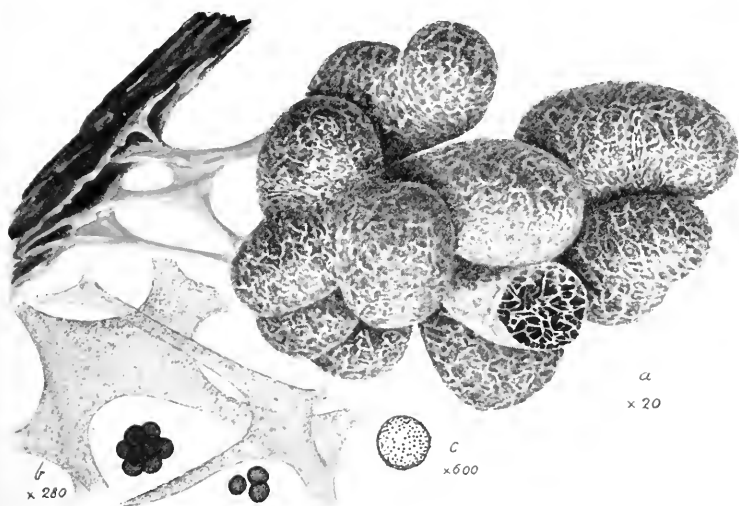


2. *BADHAMIA POPULINA* Lister



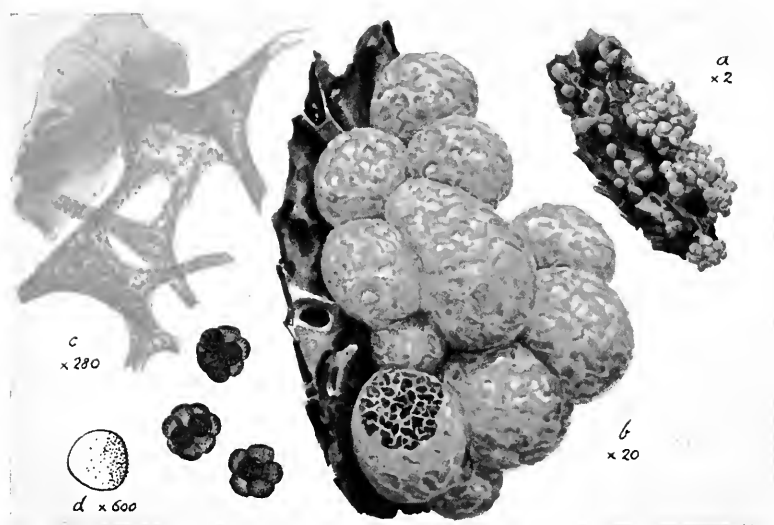


3. a—c *BADHAMIA CAPSULIFERA* Berk.  
d, e *B. PAPAVERACEA* Berk. & Rav.

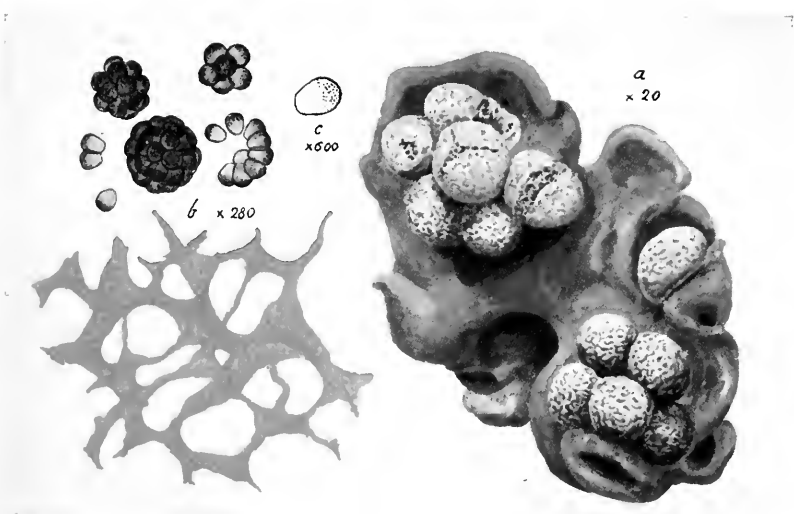


4. *BADHAMIA UTRICULARIS* Berk.





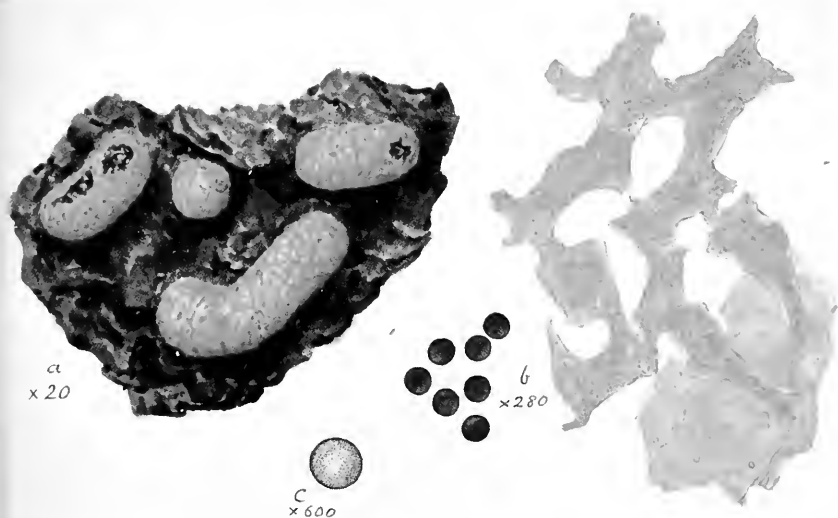
5. BADHAMIA NITENS Berk.



6. BADHAMIA VERSICOLOR Lister





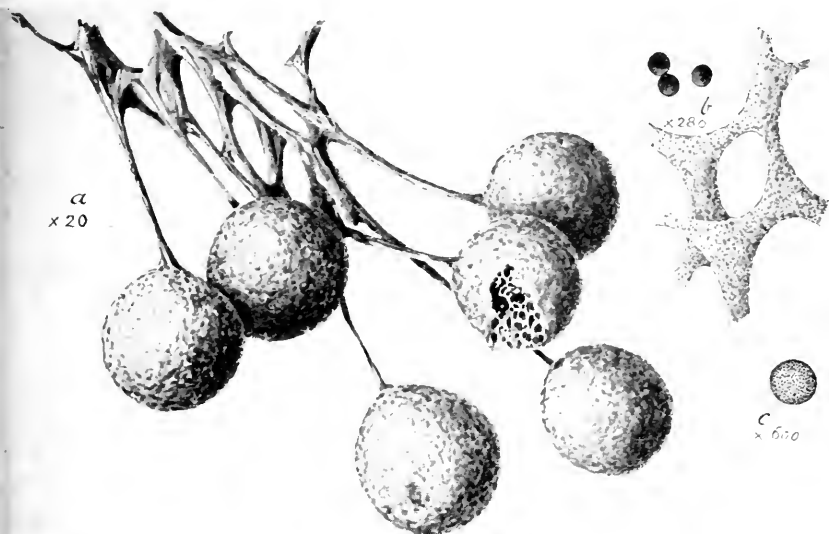


7. *BADHAMIA DECIPIENS* Berk.

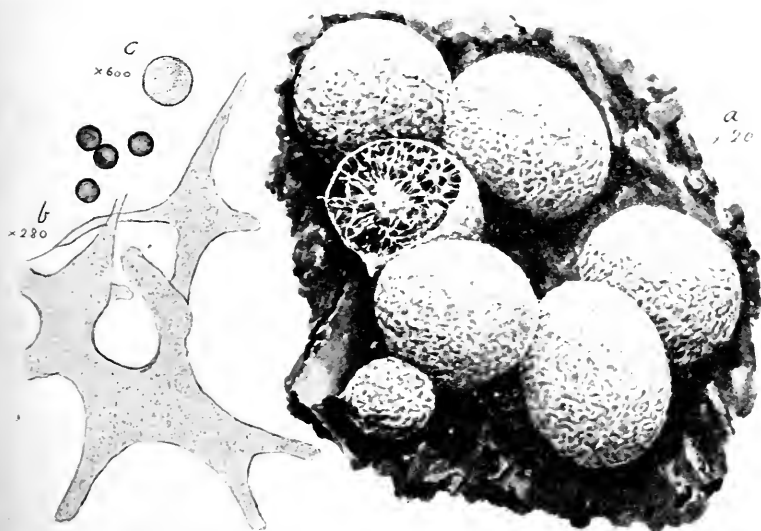


8. *a-c* *BADHAMIA MACROCARPA* Rost.  
*d-f* *B. ORBICULATA* Rex



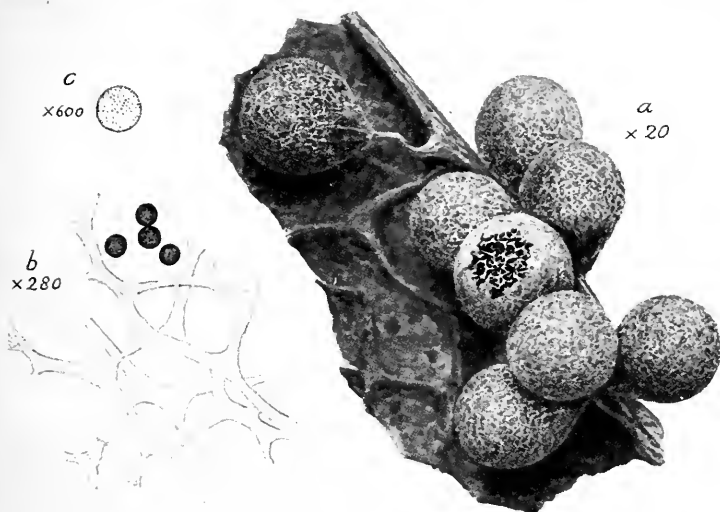


9. BADHAMIA MAGNA Peck



10. BADHAMIA PANICEA Rost.



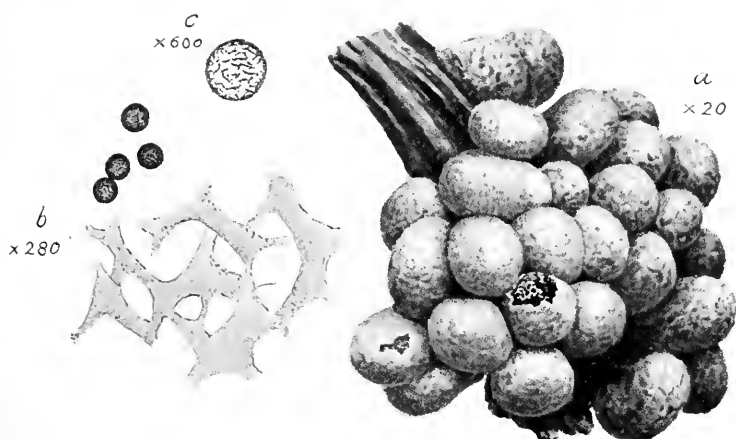


11. BADHAMIA FOLIICOLA Lister

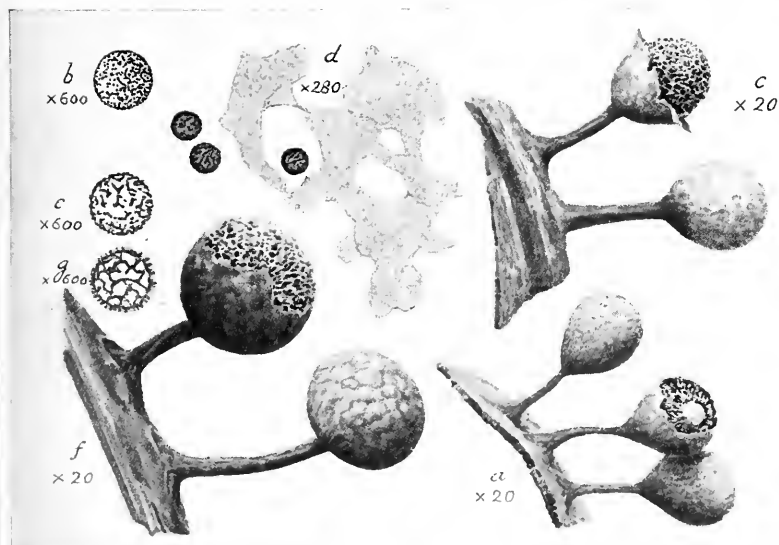


12. BADHAMIA OVISPORA Racib.





13. BADHAMIA LILACINA Rost.



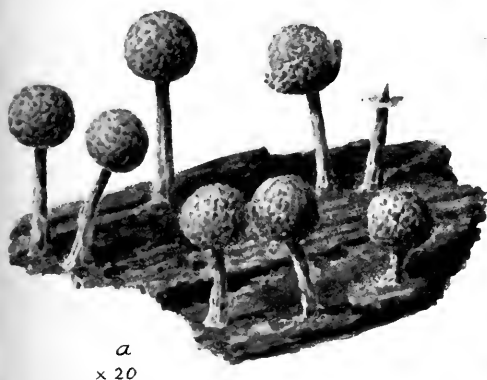
14. BADHAMIA RUBIGINOSA Rost.



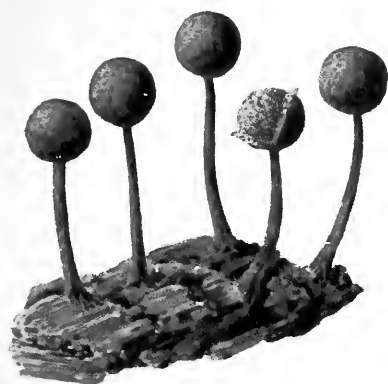


15. *PHYSARUM LEUCOPUS* Link16. *PHYSARUM GLOBULIFERUM* Pers.

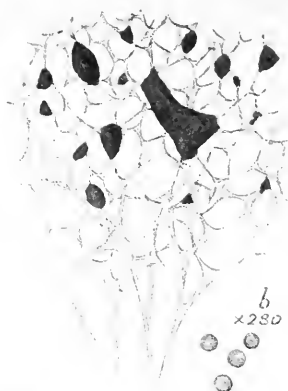


17. *PHYSARUM PULCHRIPIPES* Peck18. *PHYSARUM MURINUM* Lister





*a*  
× 20



*b*  
× 280

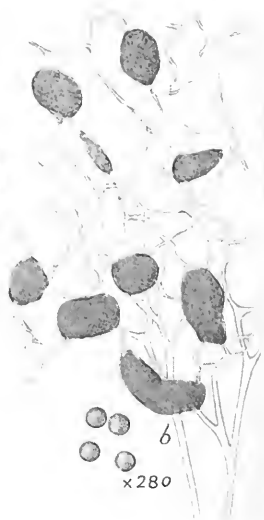


*c*  
× 600

19. *PHYSARUM PULCHERRIMUM* Berk. & Rav.



*a*  
× 20



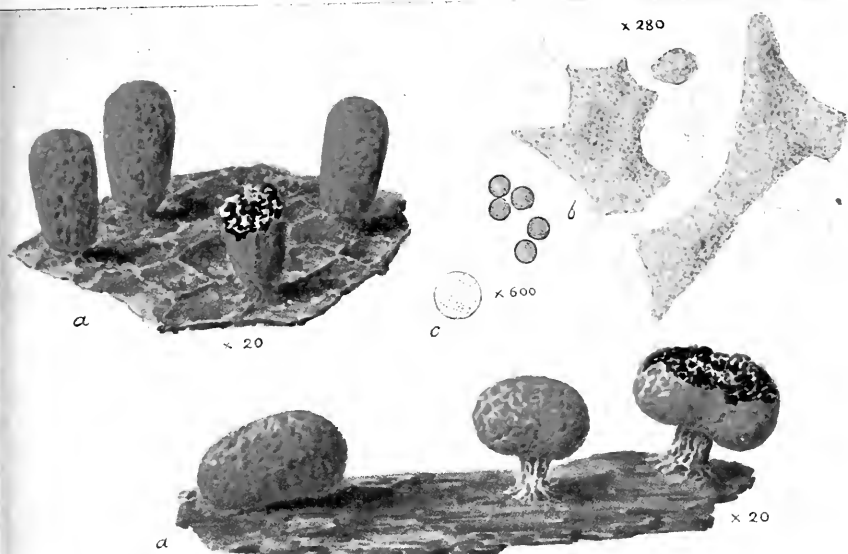
*b*  
× 280



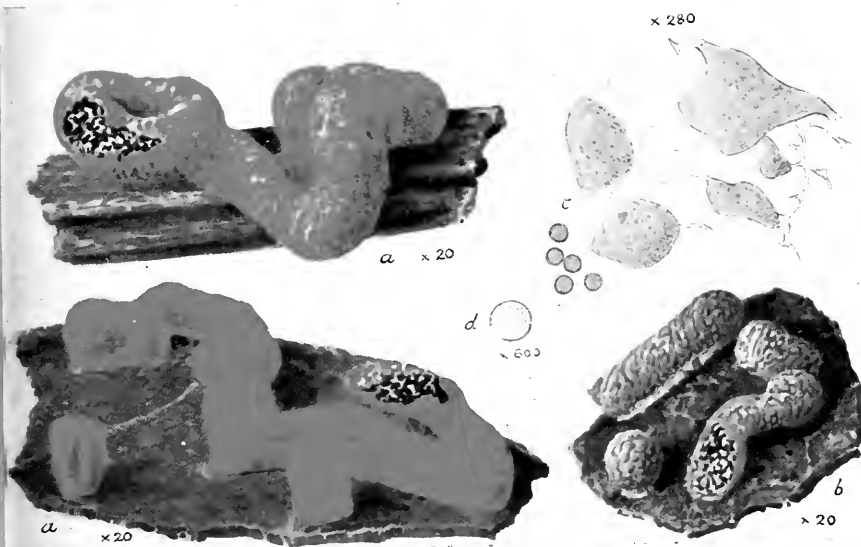
*c*  
× 600

20. *PHYSARUM CITRINUM* Schum.





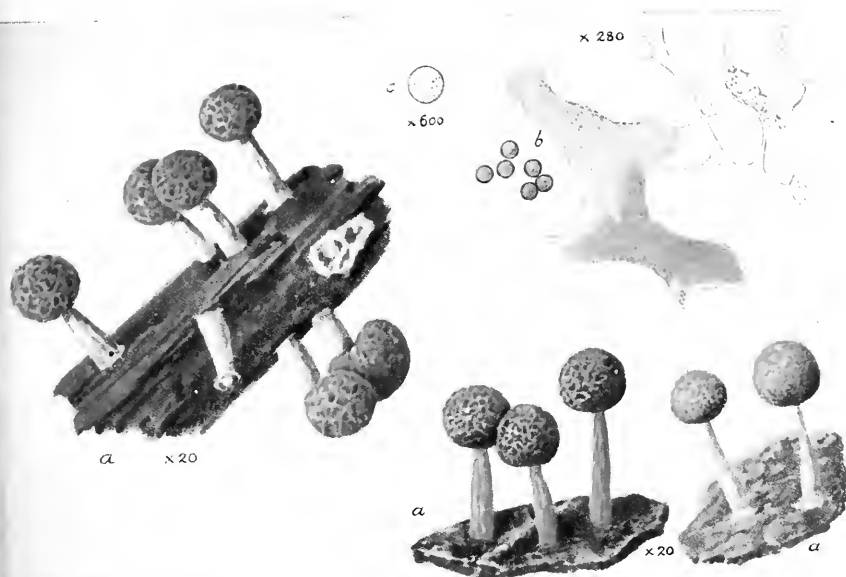
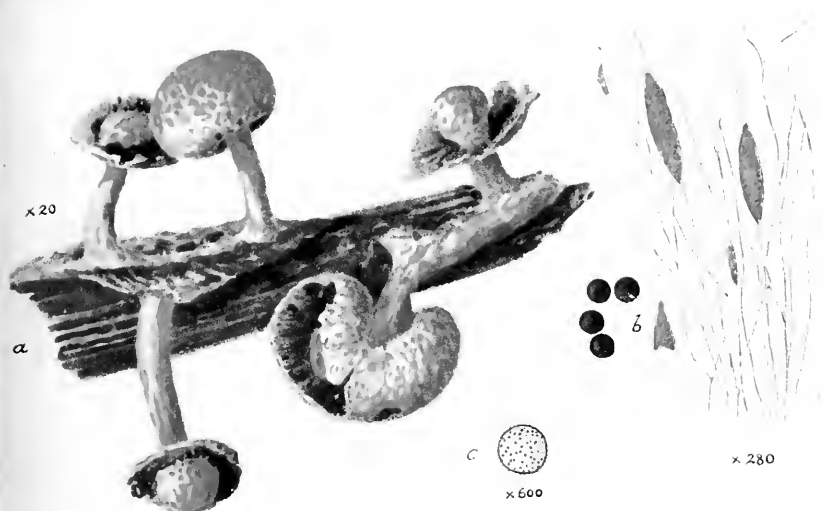
21. *PHYSARUM VARIABILE* Rex



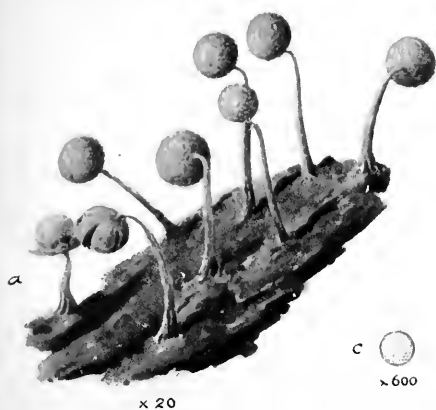
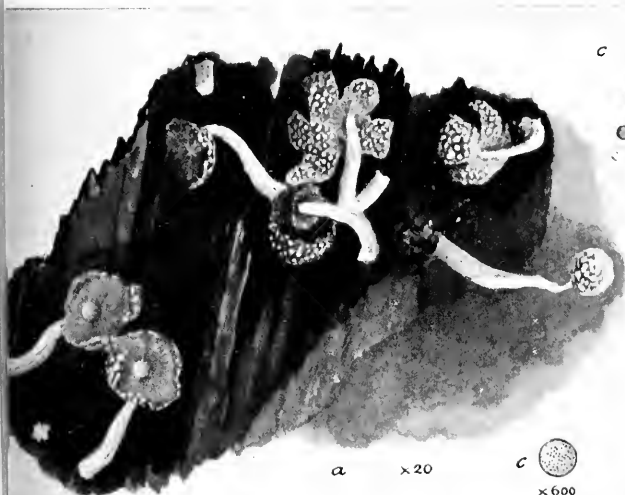
22. *PHYSARUM VARIABILE* var. *SESSILE* Lister



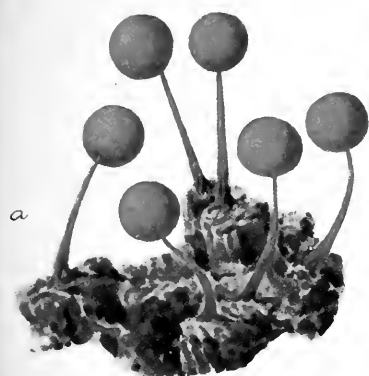


23. *PHYSARUM MELLEUM* Massee24. *PHYSARUM LUTEOALBUM* Lister



25. *PHYSARUM TENERUM* Rex26. *PHYSARUM COMPACTUM* Lister





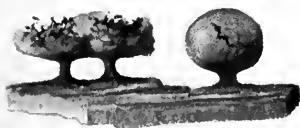
x 20



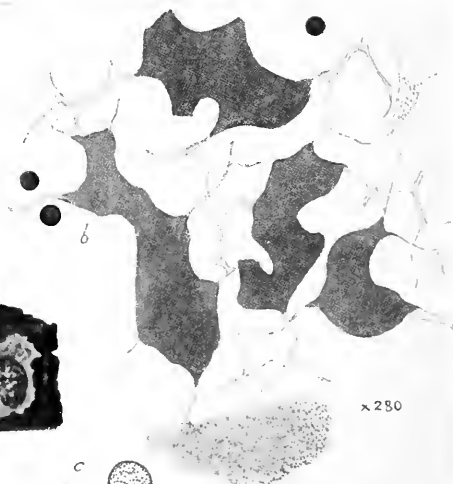
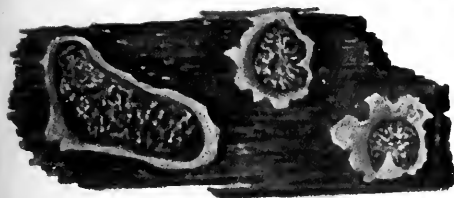
x 280



x 600

27. *PHYSARUM ROSEUM* Berk. & Br.

x 20



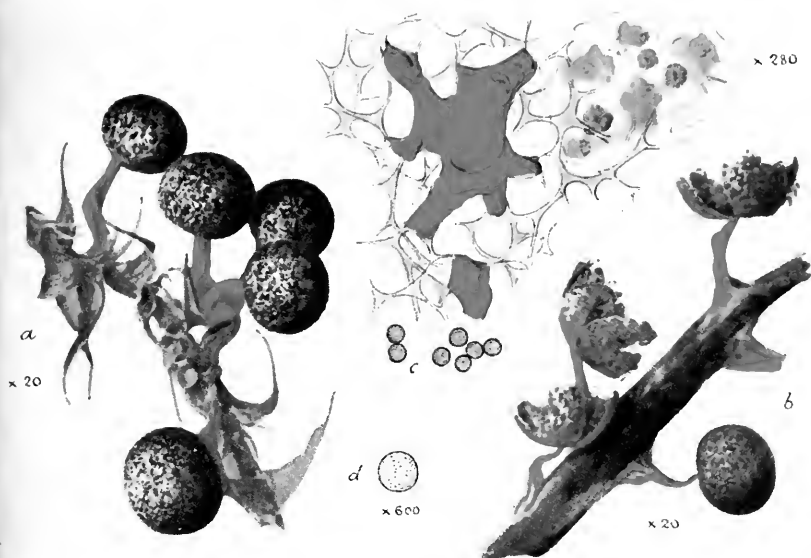
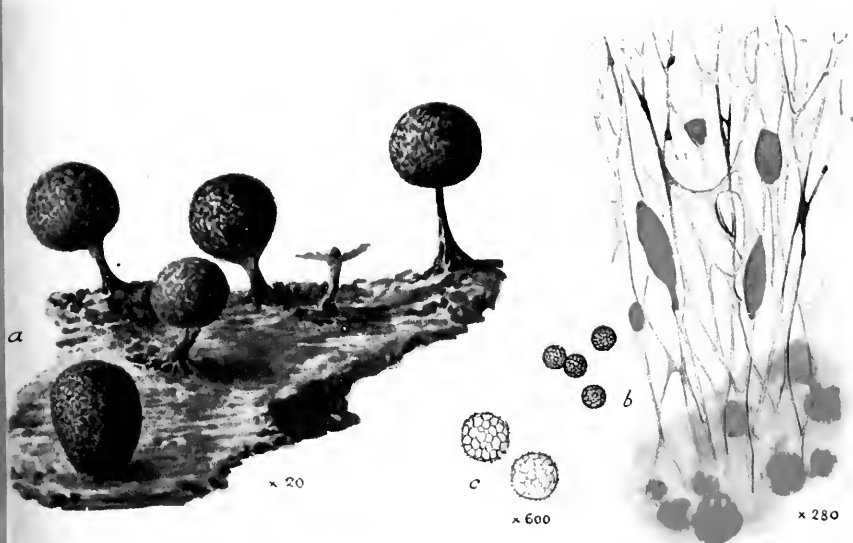
x 280



x 600

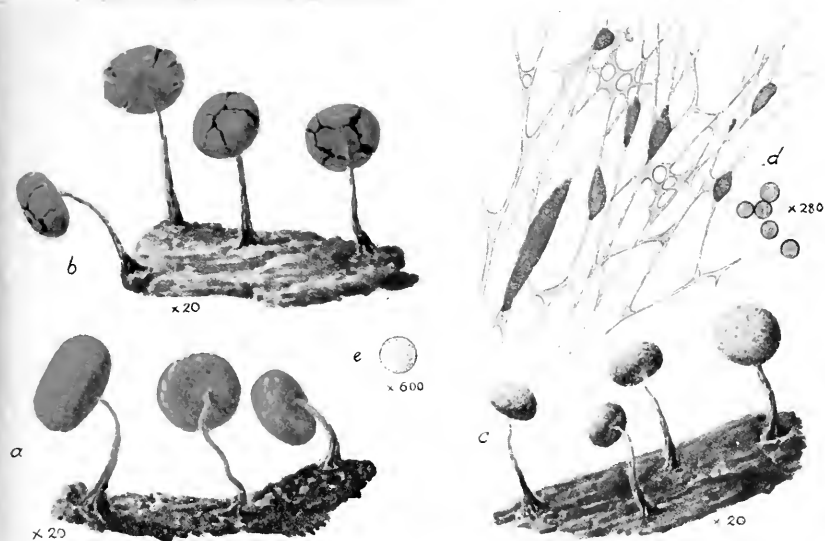
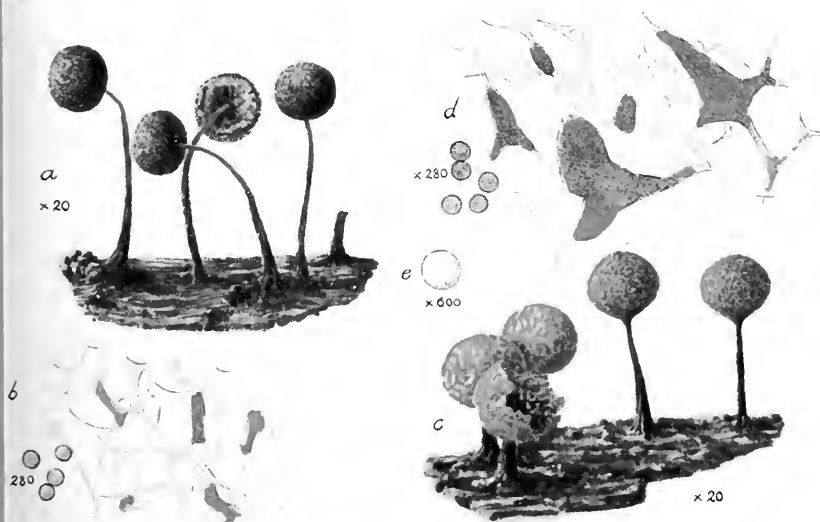
28. *PHYSARUM NEWTONI* Macbride



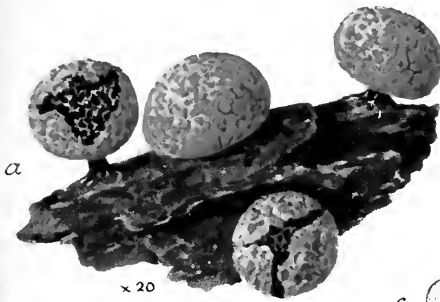
29. *PHYSARUM PSITTACINUM* Ditmar30. *PHYSARUM DICTYOSPORUM* Lister



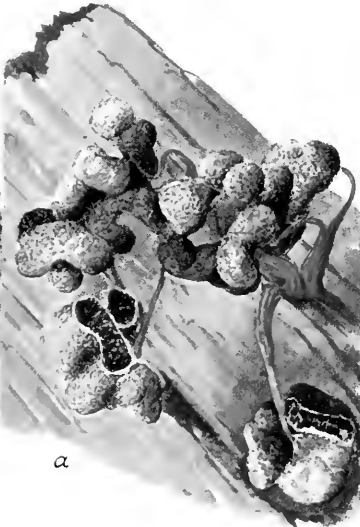


31. *PHYSARUM VIRIDE* Pers.32. c—e, *P. MAYDIS* Torrend



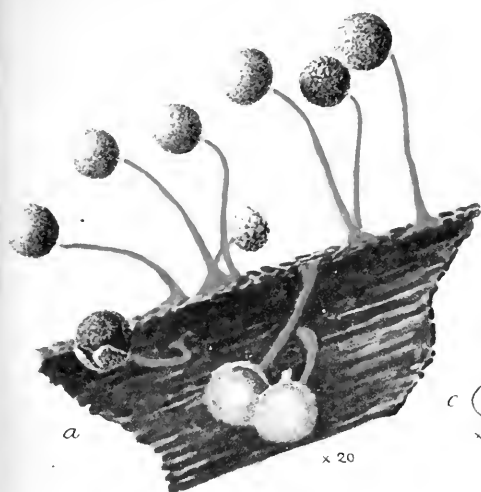


33. *PHYSARUM AURISCALPIUM* Cooke

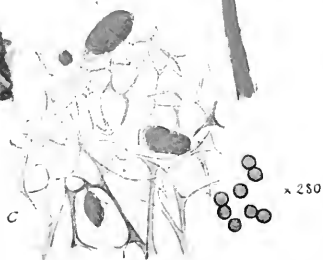
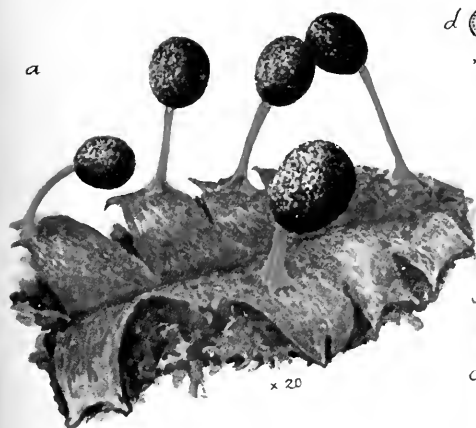


34. *PHYSARUM POLYCEPHALUM* Schwein.



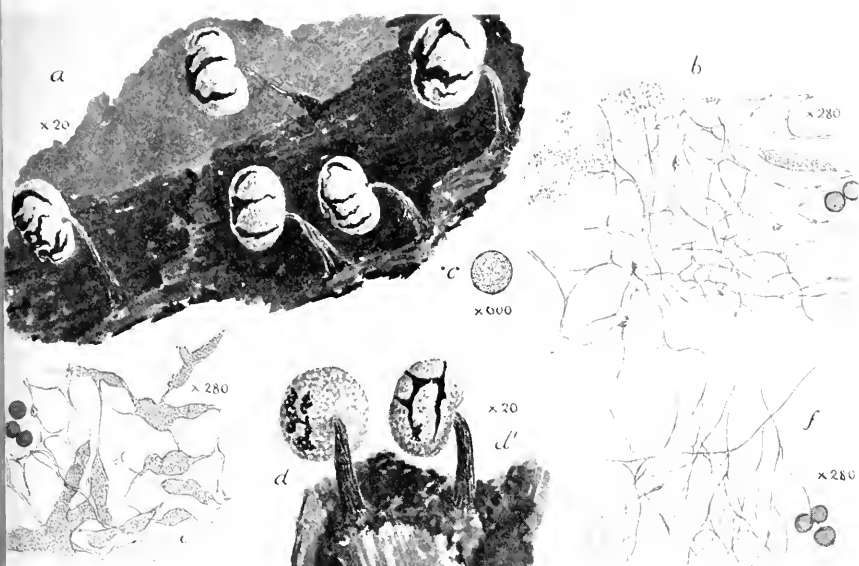
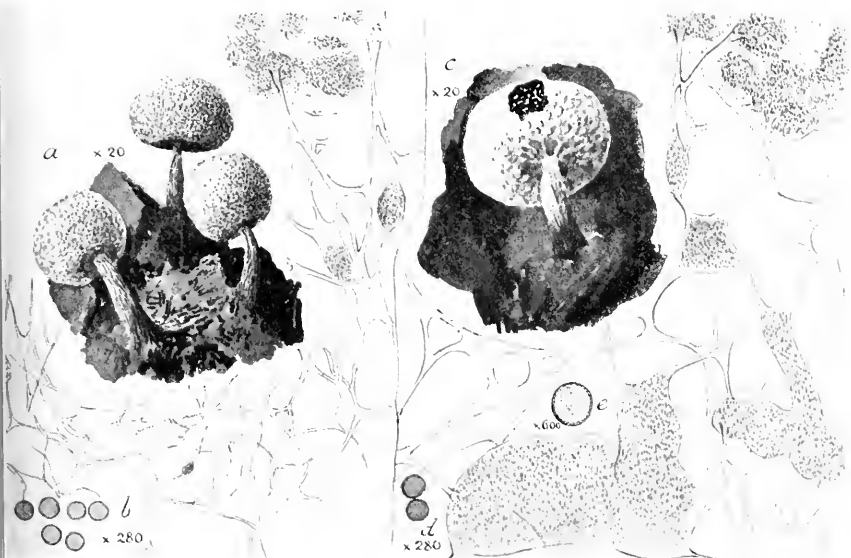


35. PHYSARUM NUCLEATUM Rex



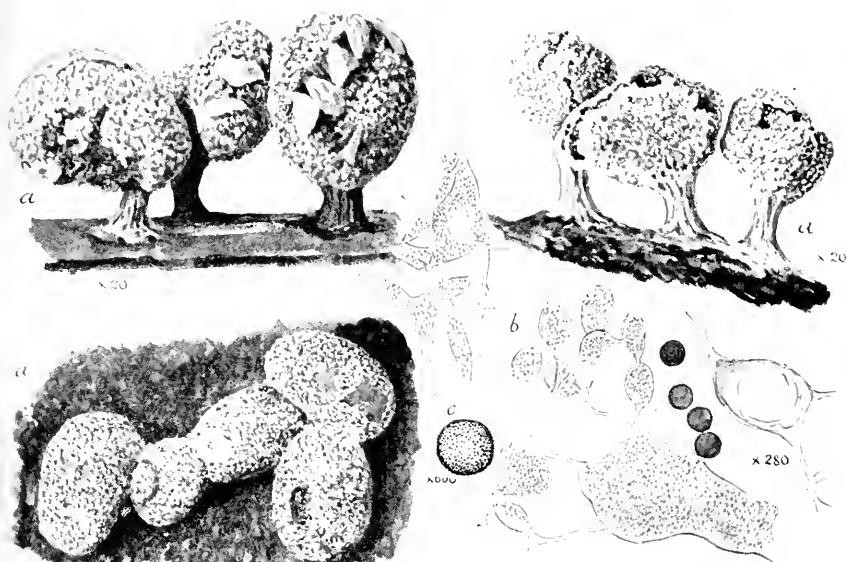
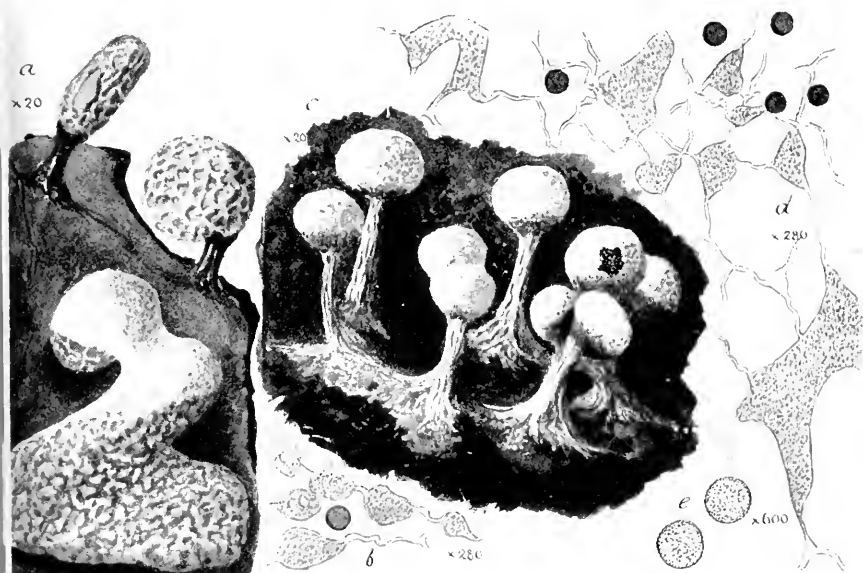
36. PHYSARUM PENETRALE Rex



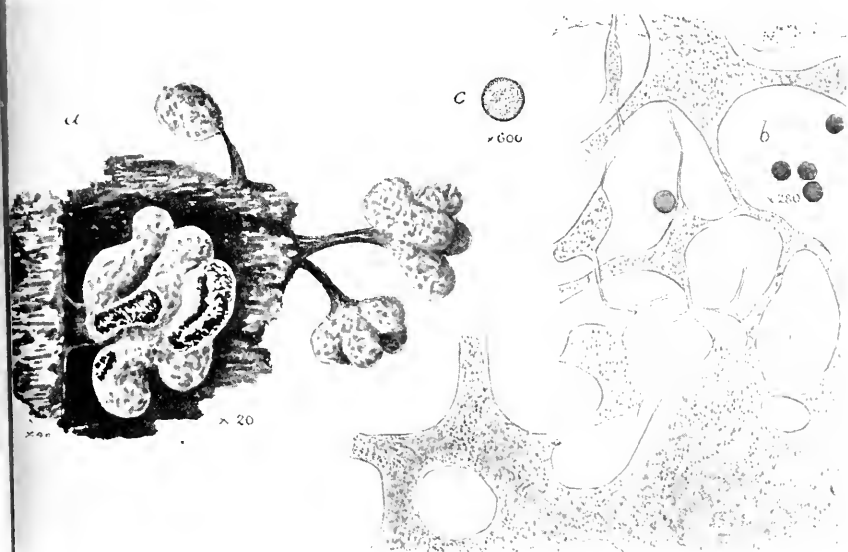
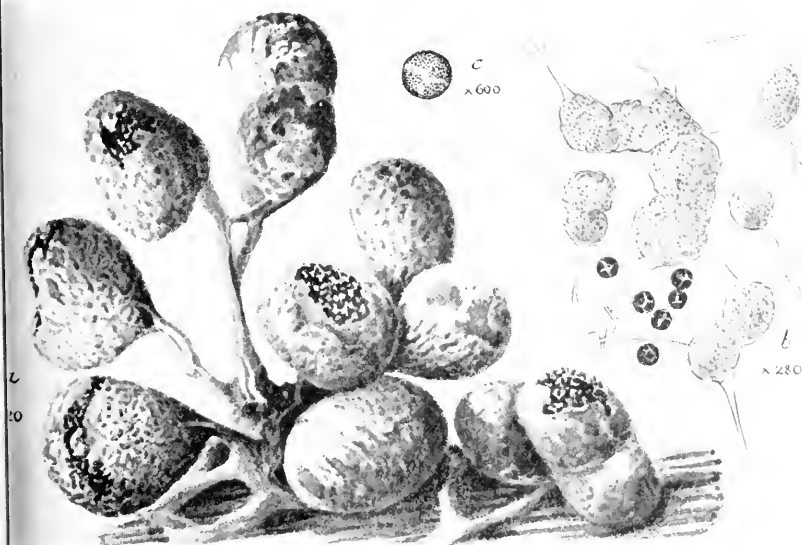
37. *PHYSARUM NUTANS* Pers.38. *PHYSARUM NUTANS* subsp. *LEUCOPHAEUM* Lister



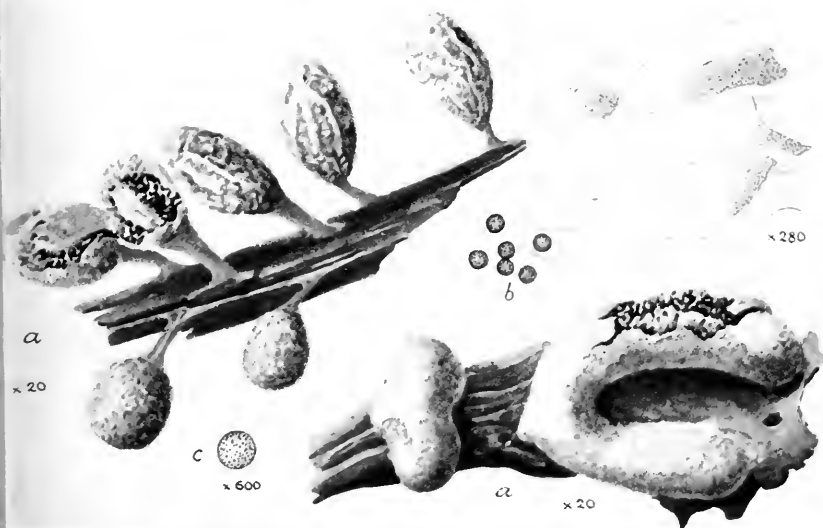


39. *PHYSARUM COMPRESSUM* Alb. & Schw.40. *a, b, PHYSARUM COMPRESSUM* Alb. & Schw.;  
*c—e, P. CONNEXUM* Morgan

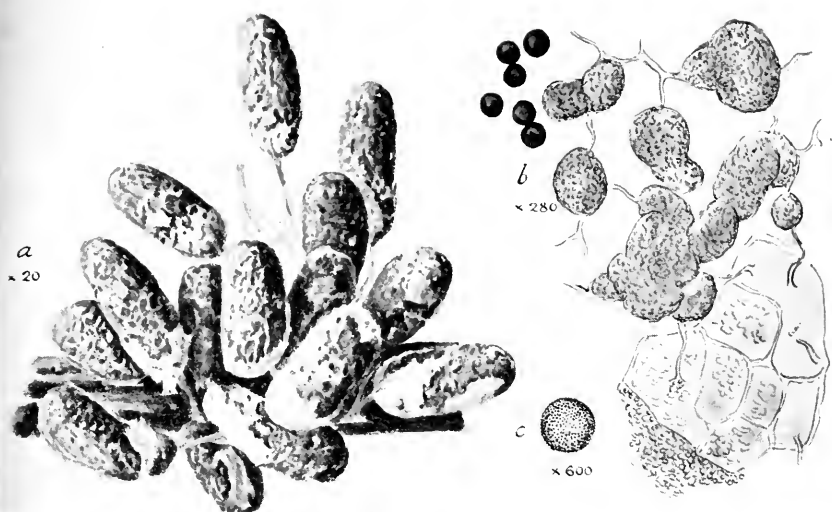
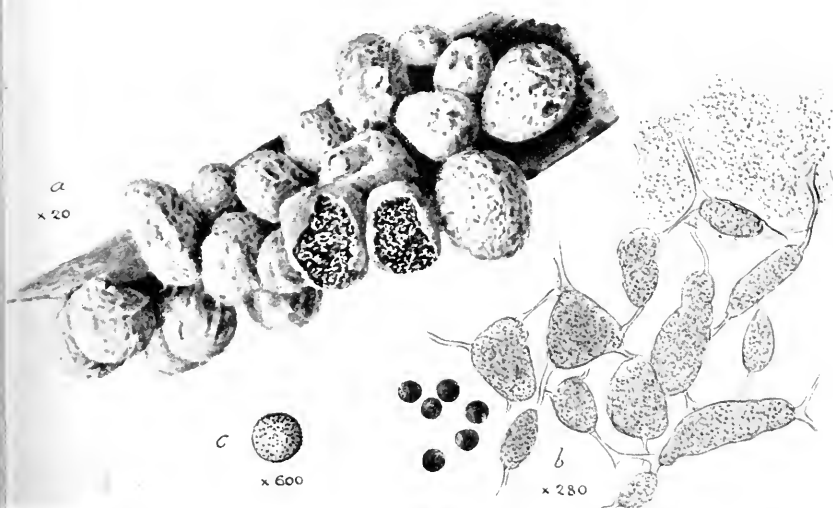


41. *PHYSARUM NICARAGUENSE* Machide42. *PHYSARUM STRAMINIPES* Lister



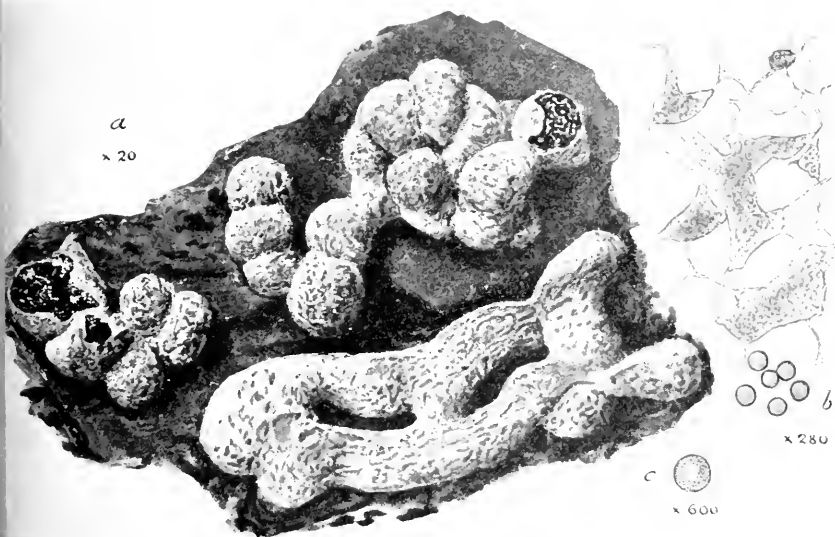
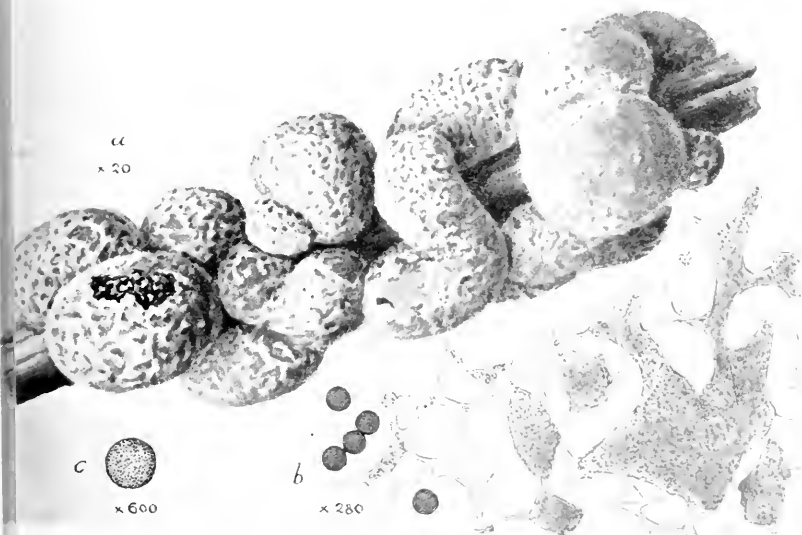
43. *PHYSARUM PUSILLUM* Lister44. *PHYSARUM MUTABILE* Lister



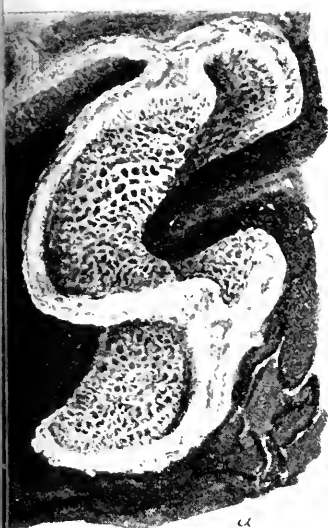
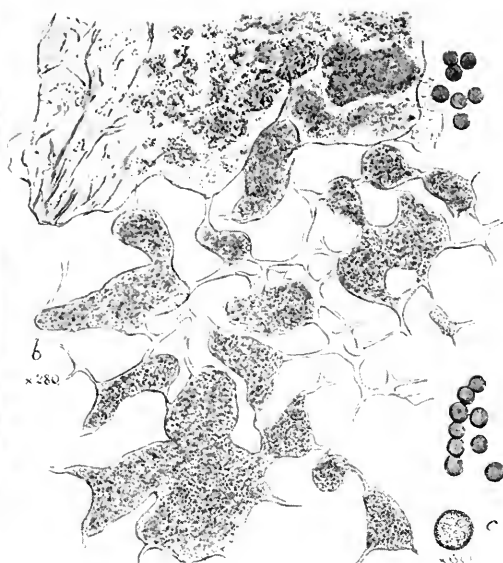
45. *PHYSARUM DIDERMOIDES* Rost.46. *PHYSARUM DIDERMOIDES* Rost. var. *LIVIDUM* Lister





47. *PHYSARUM CINEREUM* Pers.48. *PHYSARUM VERNUM* Somm.



a  
x 20

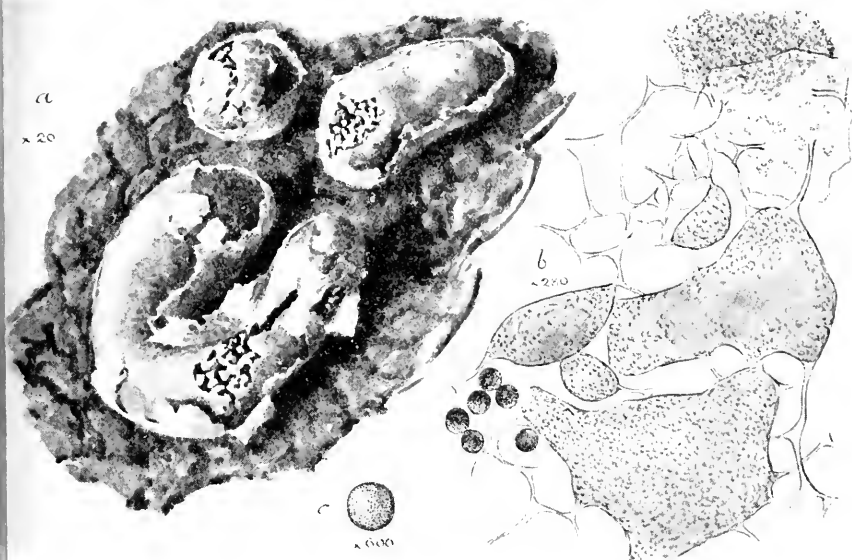
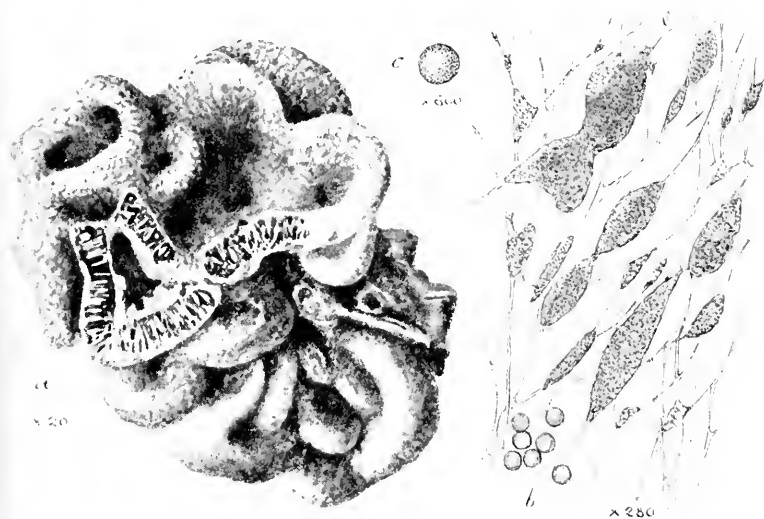
49. PHYSARUM SINUOSUM Weinm.

c  
x 500

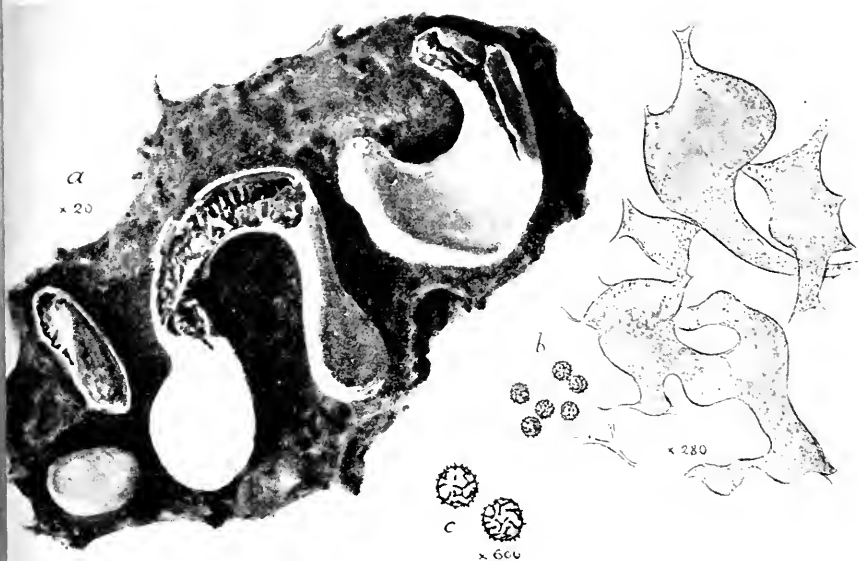
x 280

50. PHYSARUM BOGORIENSE Racib.



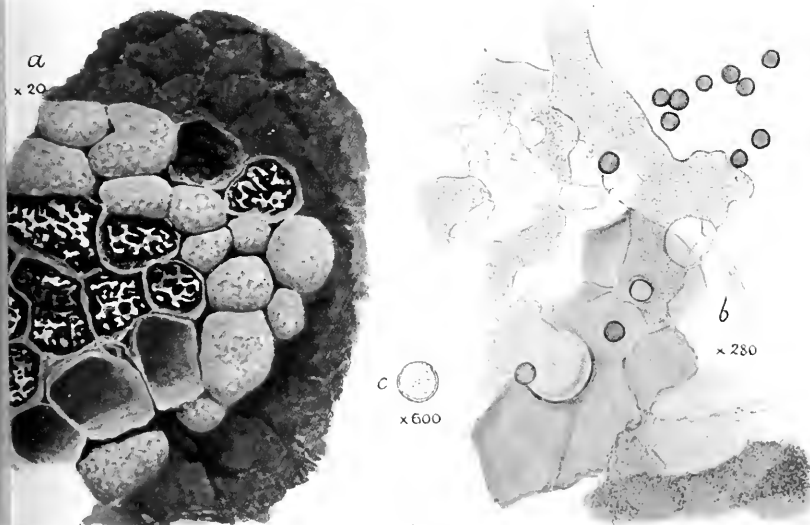
51. *PHYSARUM BITECTUM* Lister52. *PHYSARUM GYROSUM* Rost.

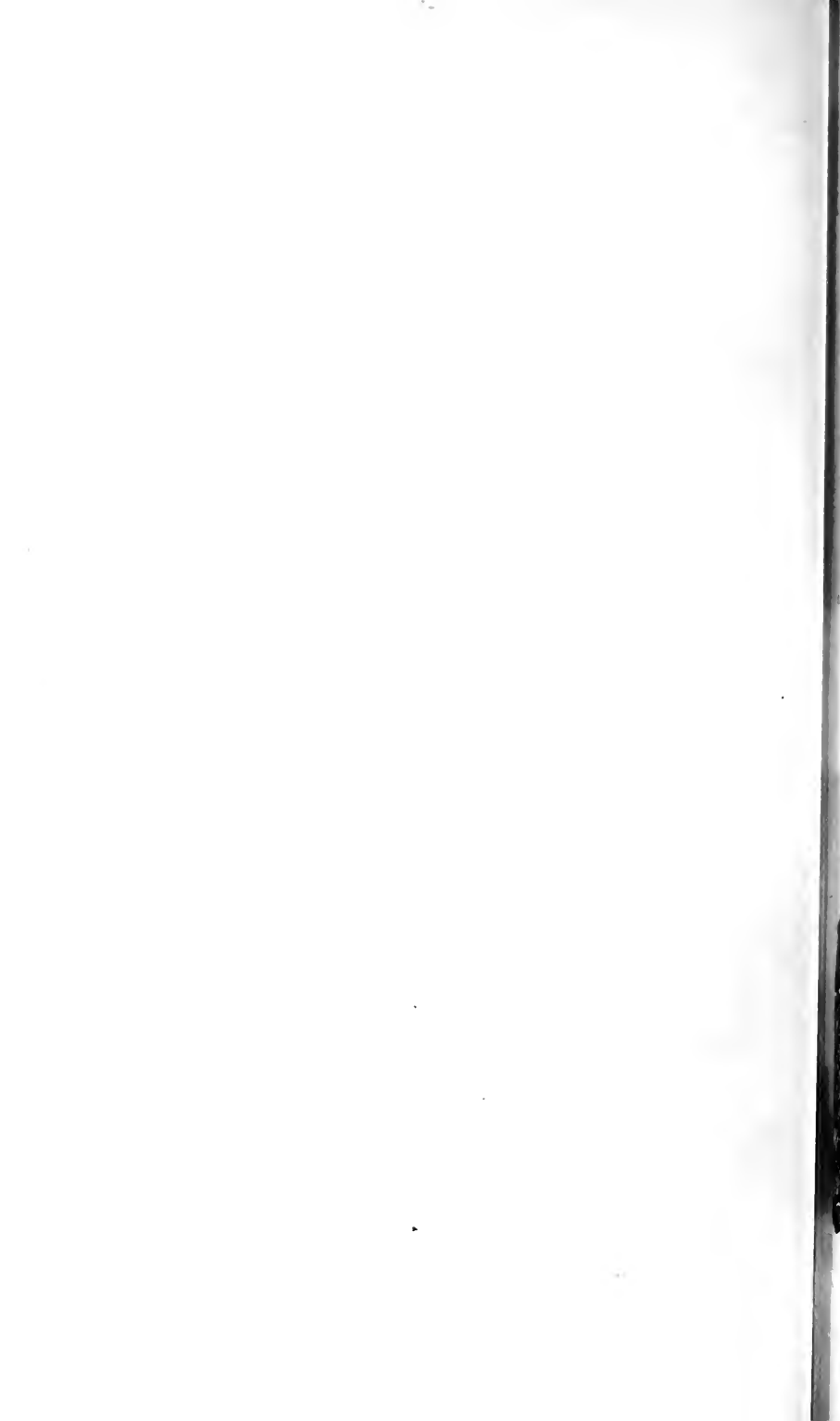


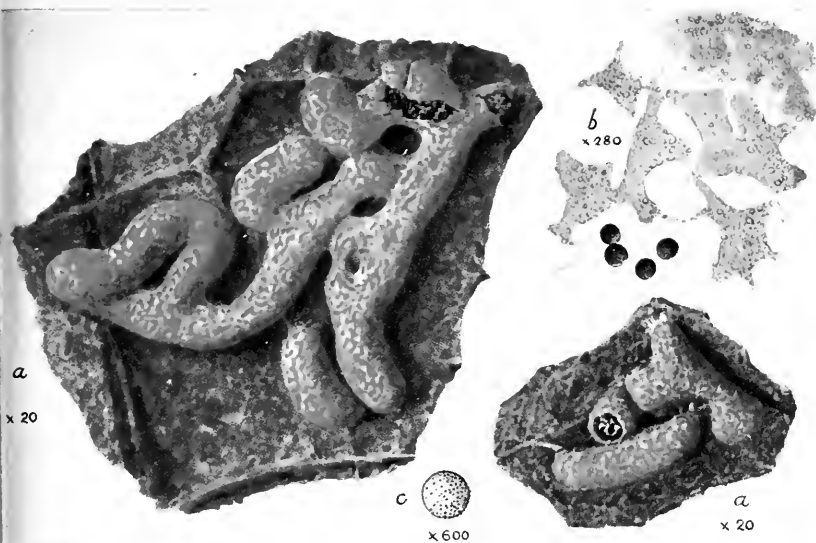
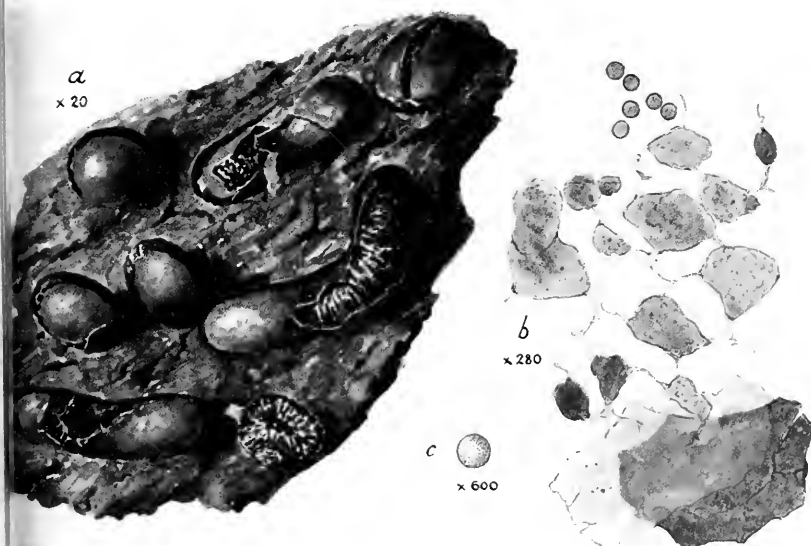
53. *PHYSARUM ECHINOSPORUM* Lister54. *PHYSARUM TESTACEUM* Sturgis



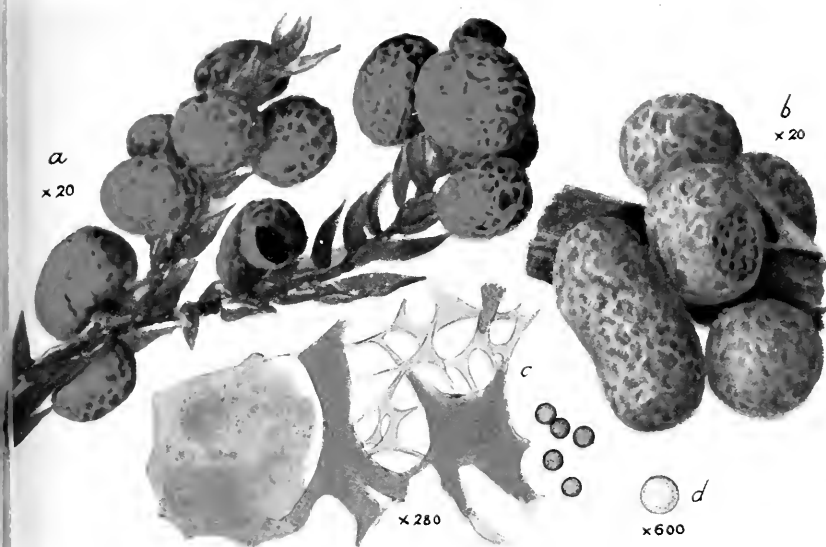
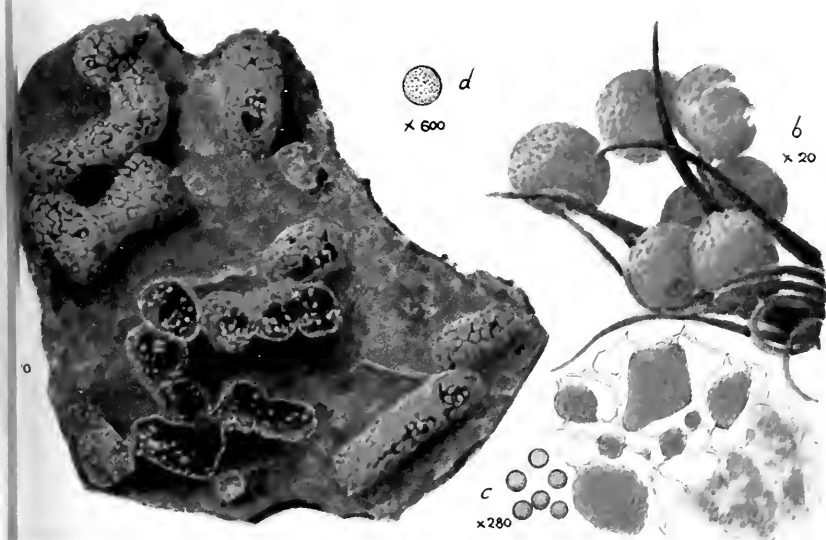


55. *PHYSARUM CONTEXTUM* Pers.56. *PHYSARUM CONGLOMERATUM* Rost.

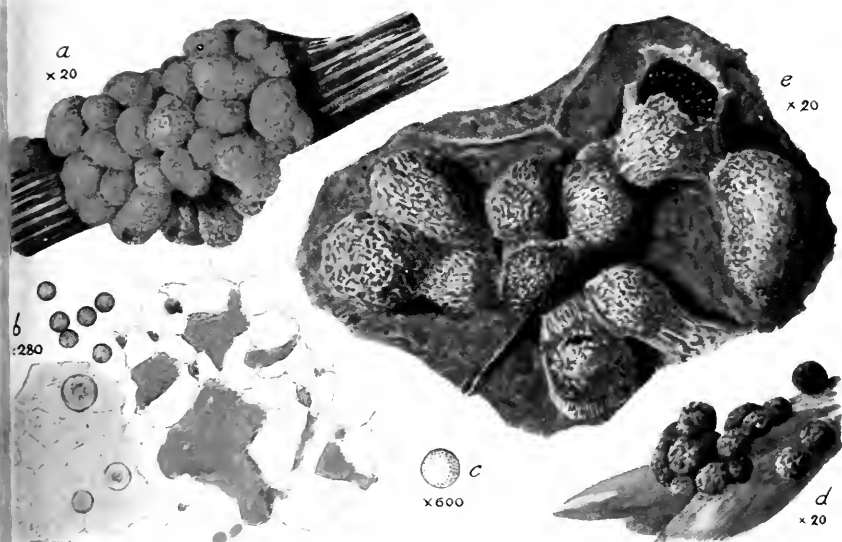
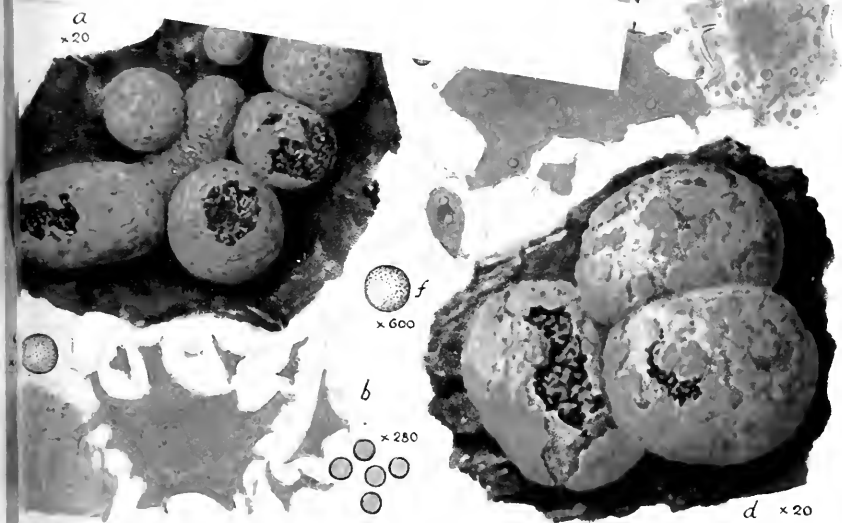


57. *PHYSARUM SERPULA* Morgan58. *PHYSARUM LÆNEUM* R. Fries



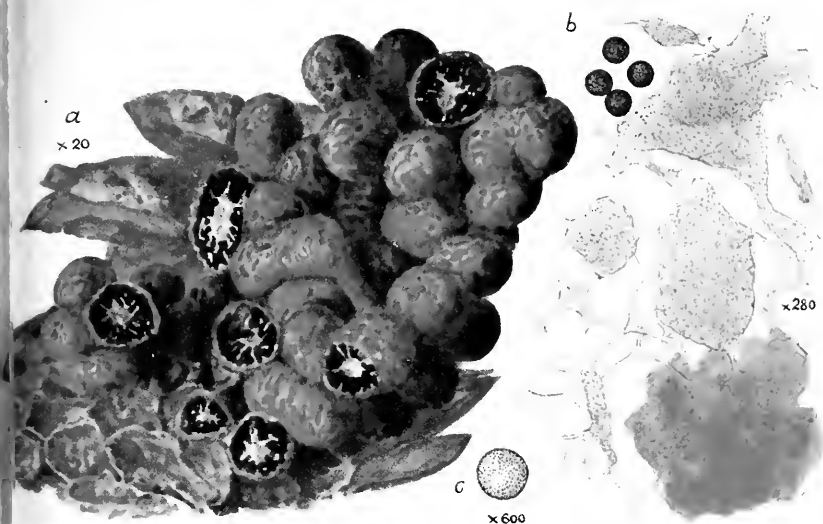
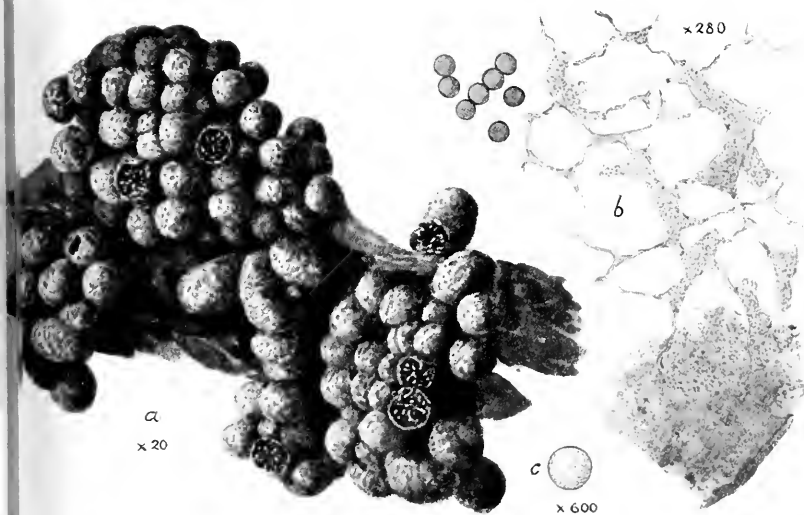
59. *PHYSARUM RUBIGINOSUM* Fries60. *PHYSARUM LATERITIUM* Lister



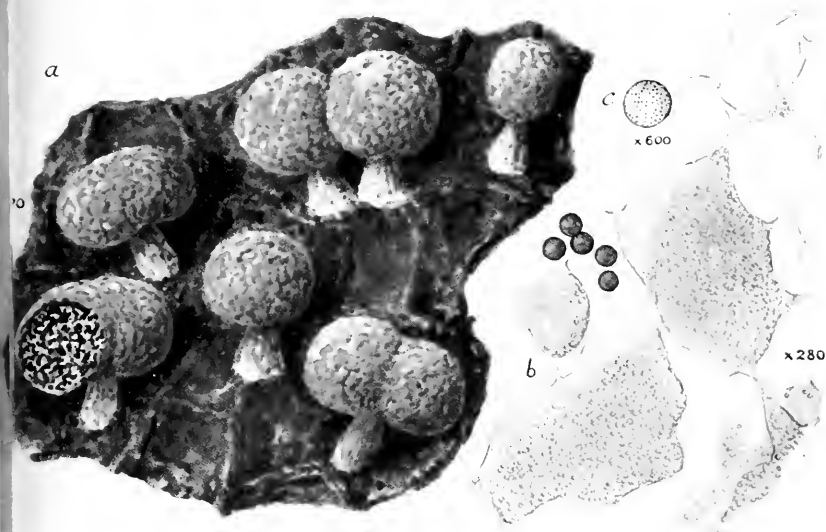
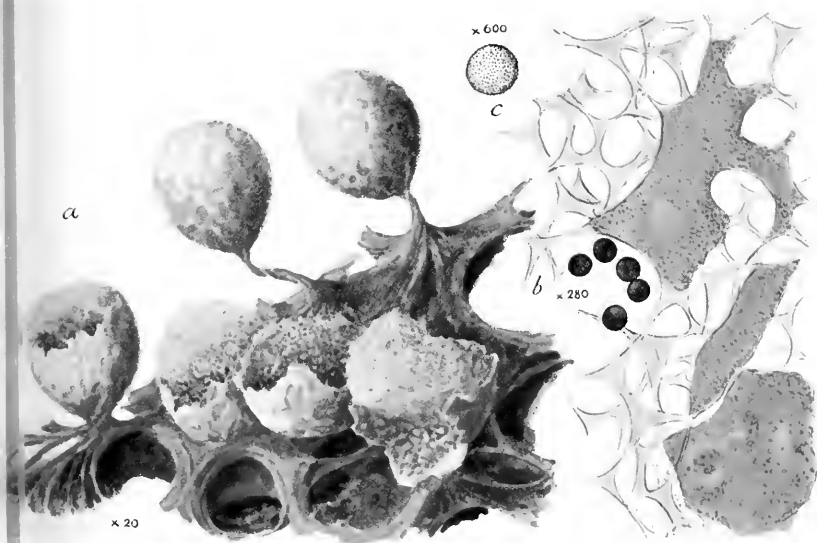
61. *PHYSARUM VIRESCENS* Ditmar*LATERITIUM* Morgan62. *a-c* *PHYSARUM VIRESCENS* Ditmar var. *NITENS* Lister  
*d-f* *P. ALPINUM* Lister



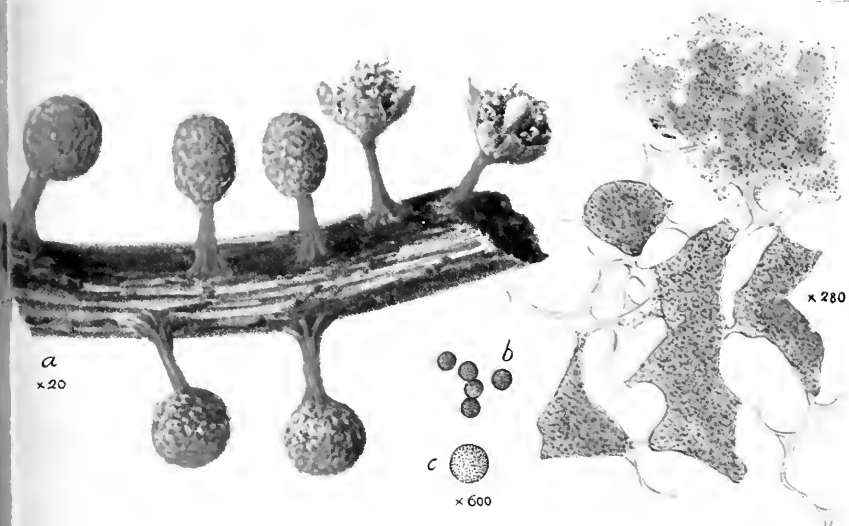


63. *PHYSARUM GULIELMÆ* Penzig64. *PHYSARUM ATRUM* Schweinitz

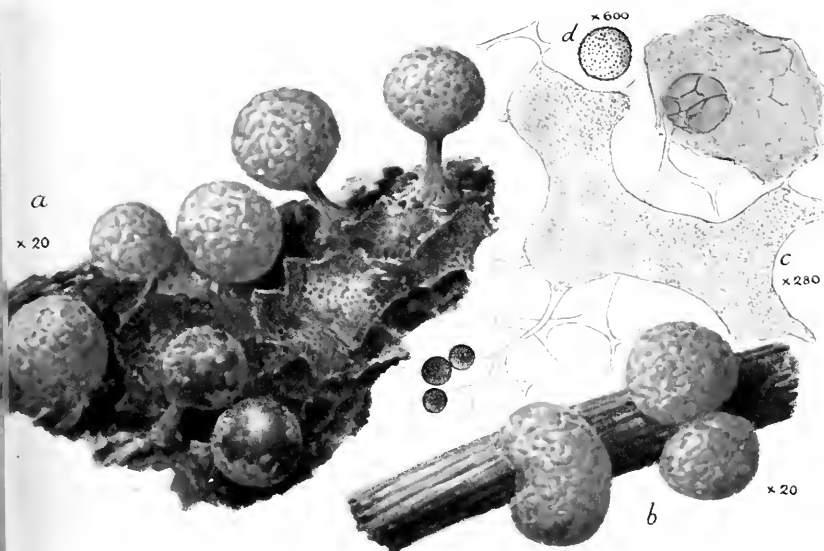


65. *PHYSARUM SULPHUREUM* Fr.66. *PHYSARUM FULVUM* Lister

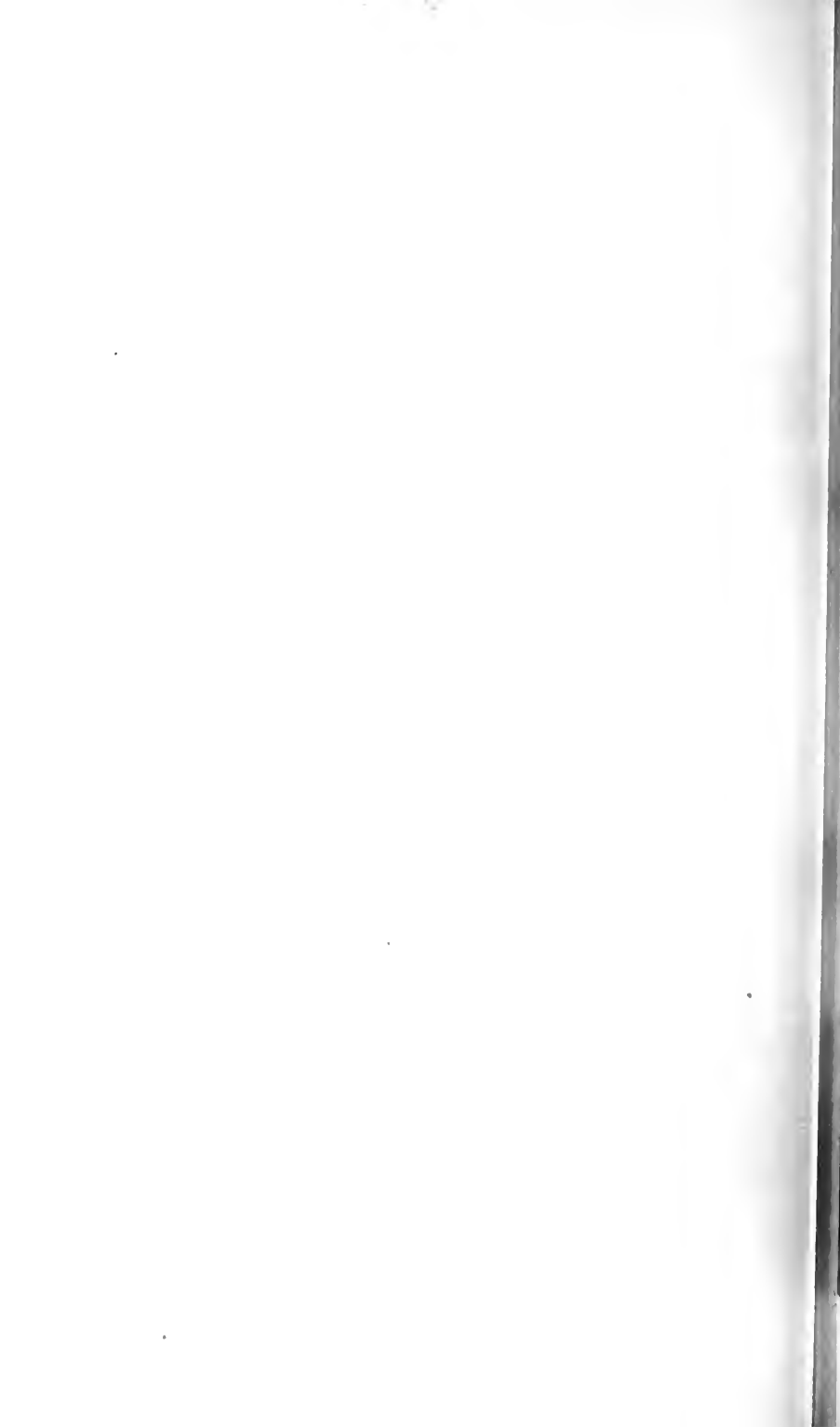


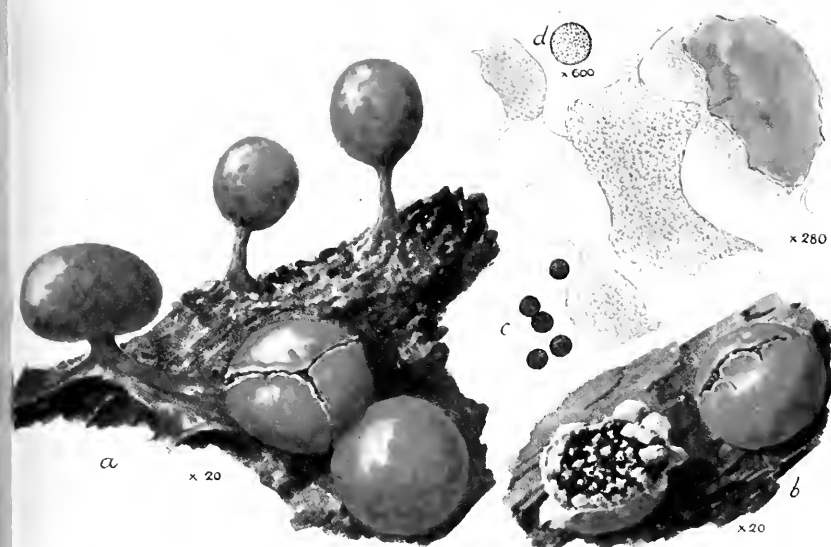
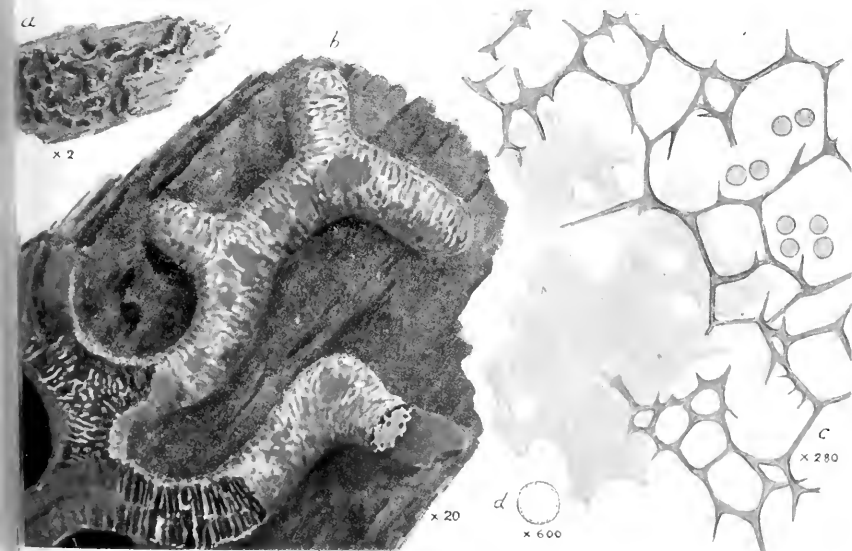


67. CRATERIUM AUREUM Rost



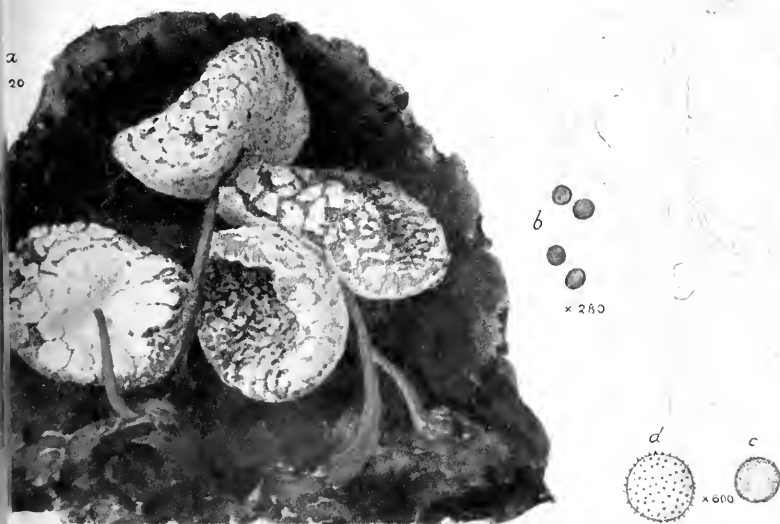
68. PHYSARUM CITRINELLUM Peck

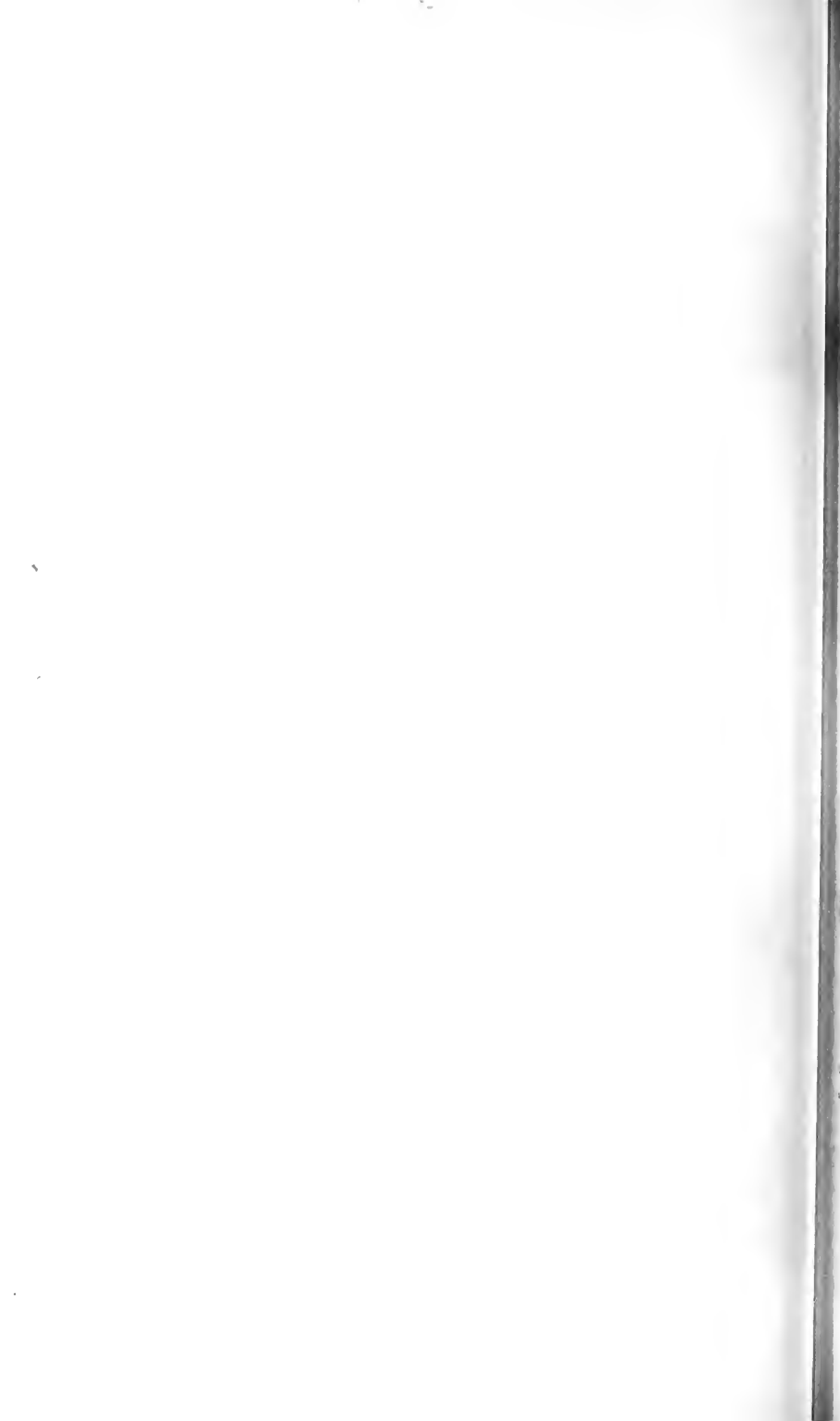


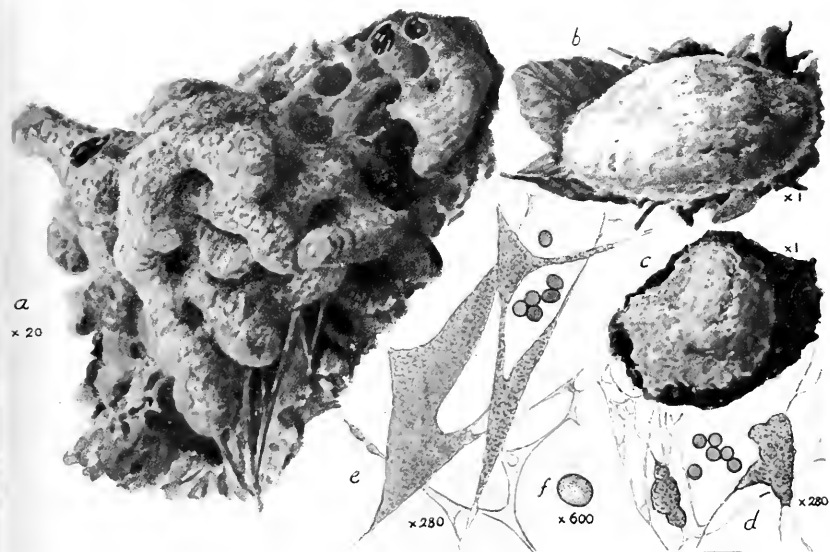
69. *PHYSARUM BRUNNEOLUM* Phillips70. *CIENKOWSKIA RETICULATA* Rost.



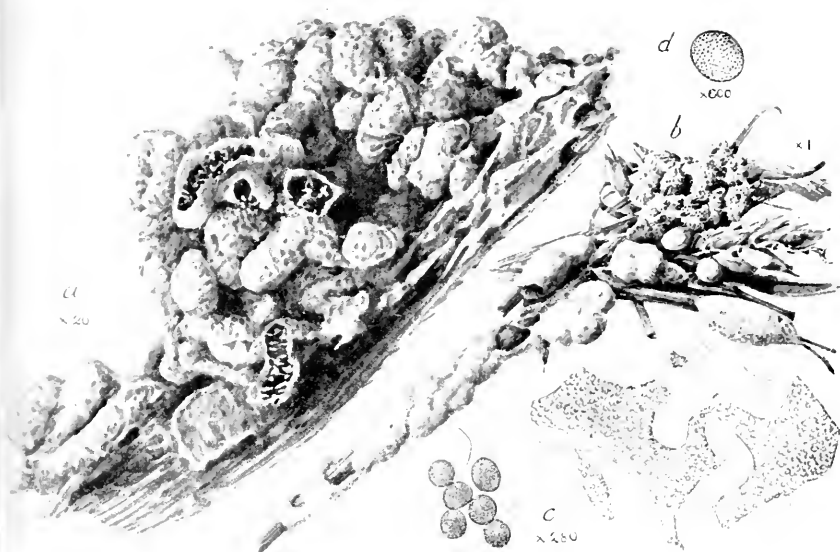
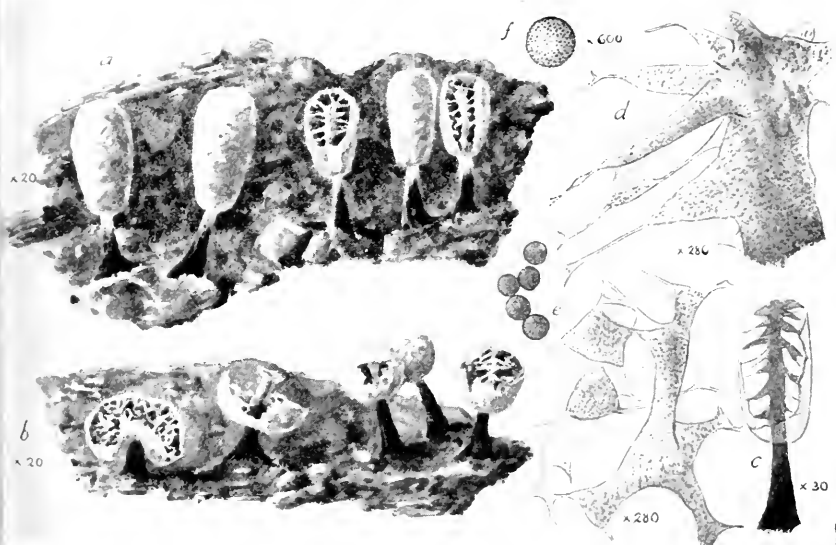


71. *PHYSARELLA OBLONGA* Morgan72. *TRICHAMPHORA PEZIZOIDEA* Jungh.

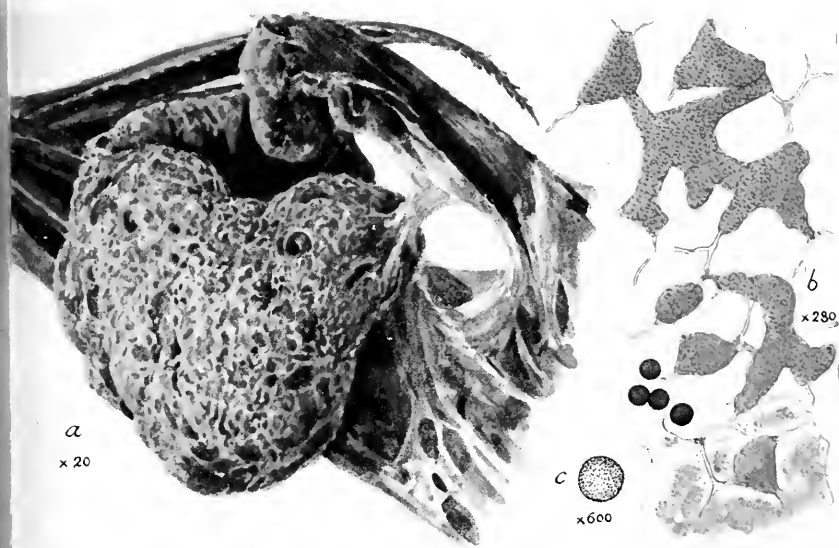
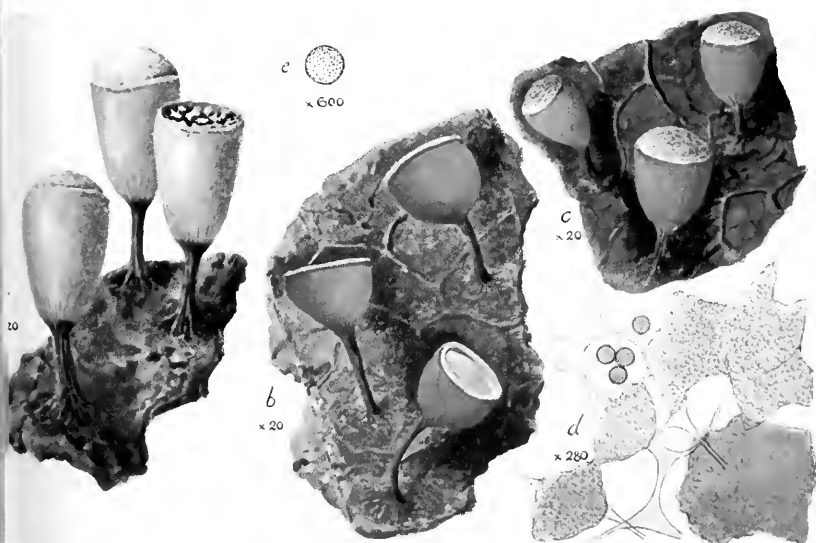


73. *ERIONEMA AUREUM* Penzig74. *FULIGO SEPTICA* Gmelin



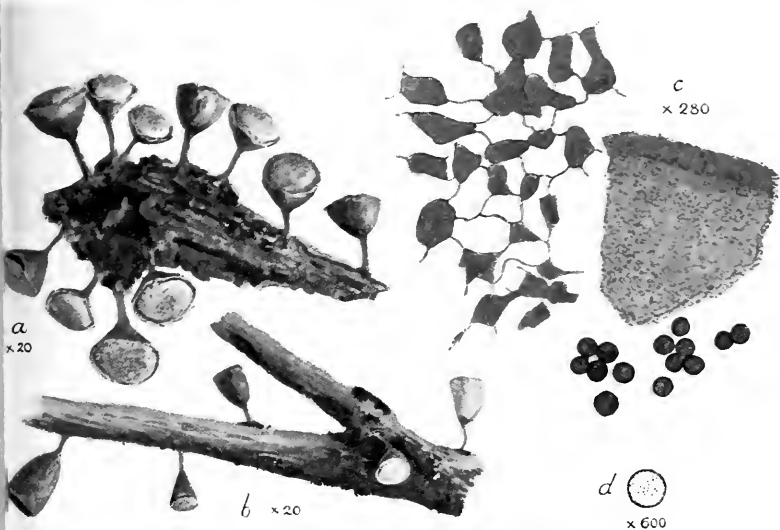
75. *FULIGO CINEREA* Morgan76. *PHYSARUM CRATERIFORME* Petch



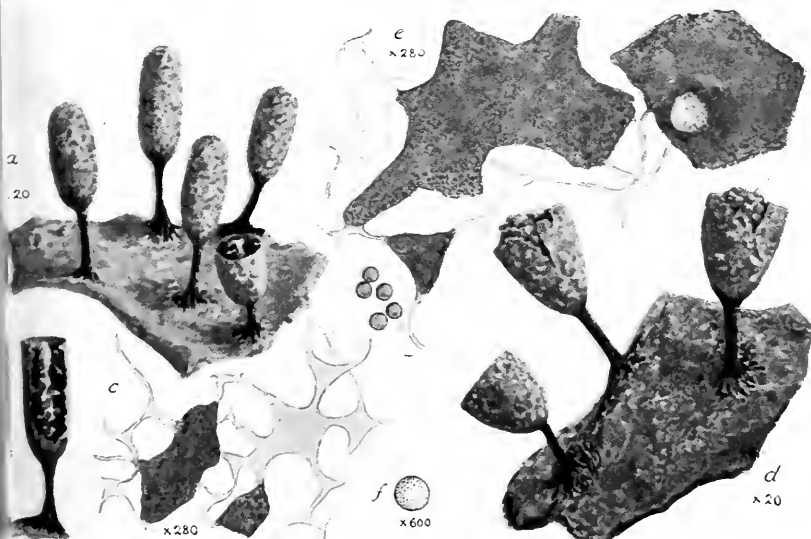
77. *FULIGO MUSCORUM* Alb. & Schwein.78. *CRATERIUM MINUTUM* Fries





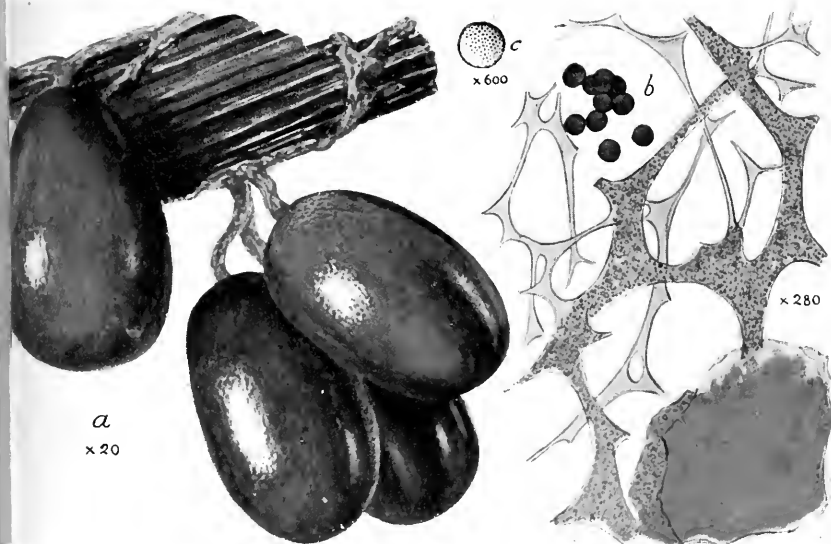
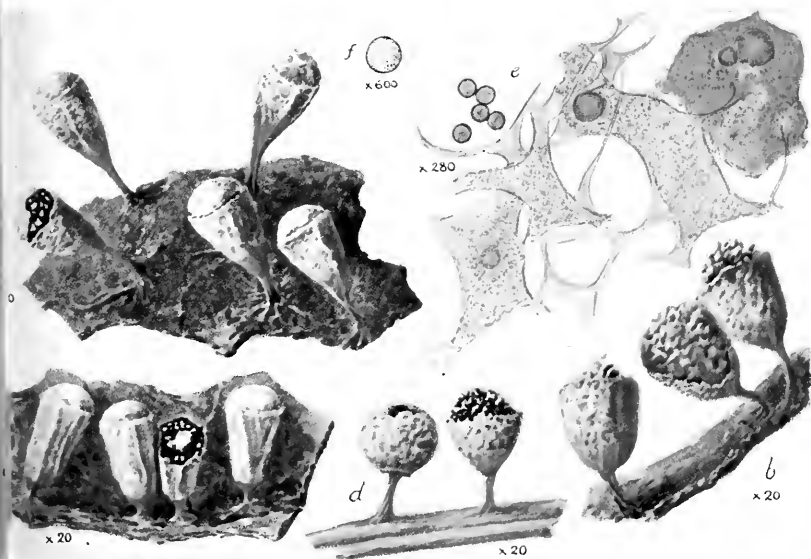


79. CRATERIUM CONCINNUM Rex

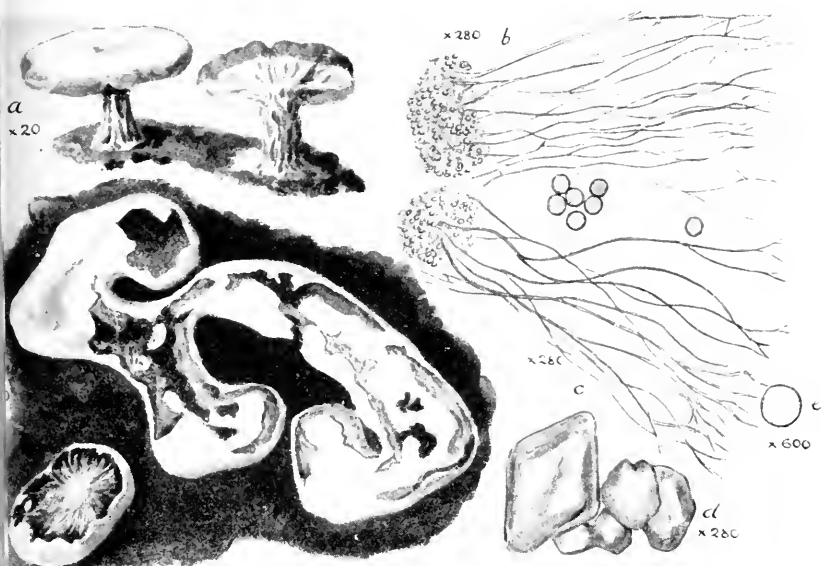


80. CRATERIUM PARAGUAYENSE Lister

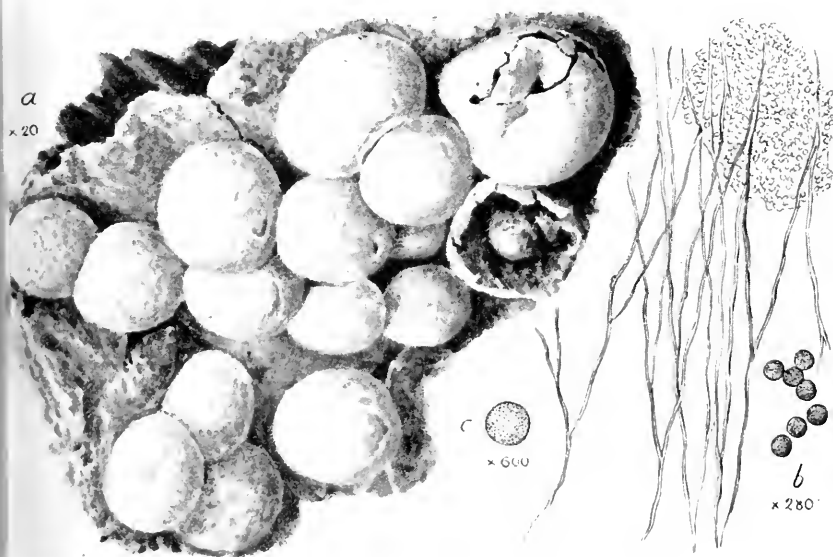


82. *LEOCARPUS FRAGILIS* Rost.81. *CRATERIUM LEUCOCEPHALUM* Ditmar



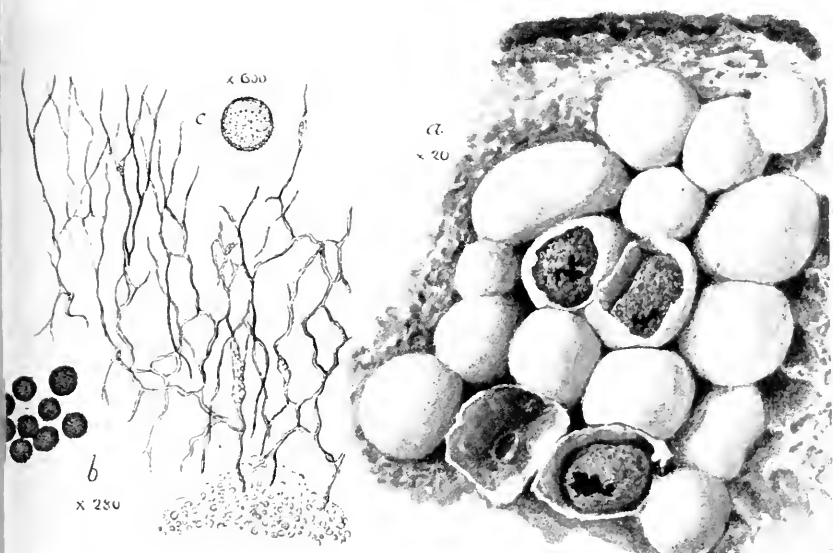
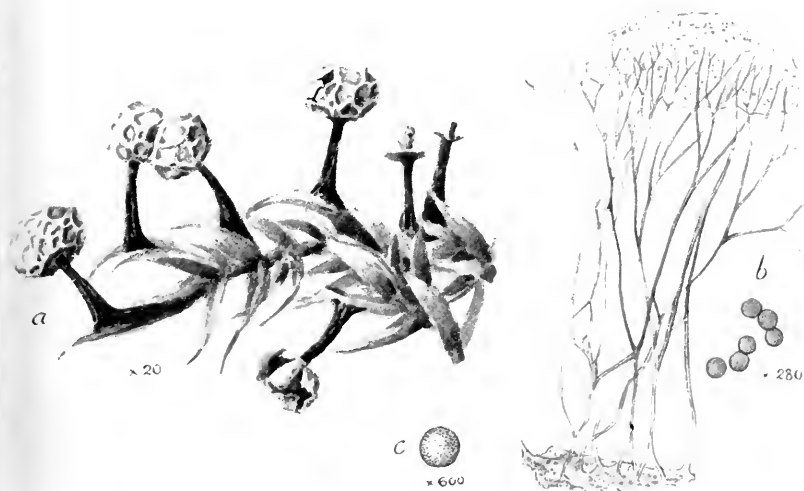


83. *a—e*, *DIDERMA HEMISPHERICUM* Hornem.;  
*f*, *D. EFFUSUM* Morgan



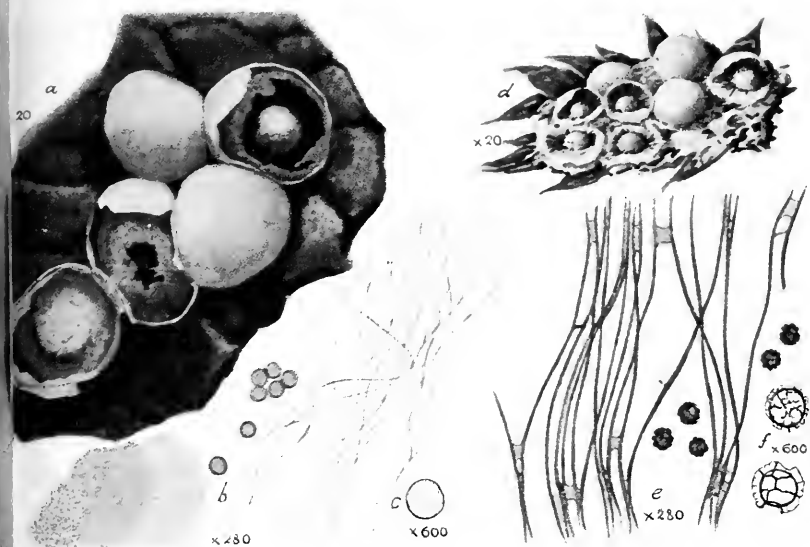
84. *DIDERMA SPUMARIOIDES* Fries



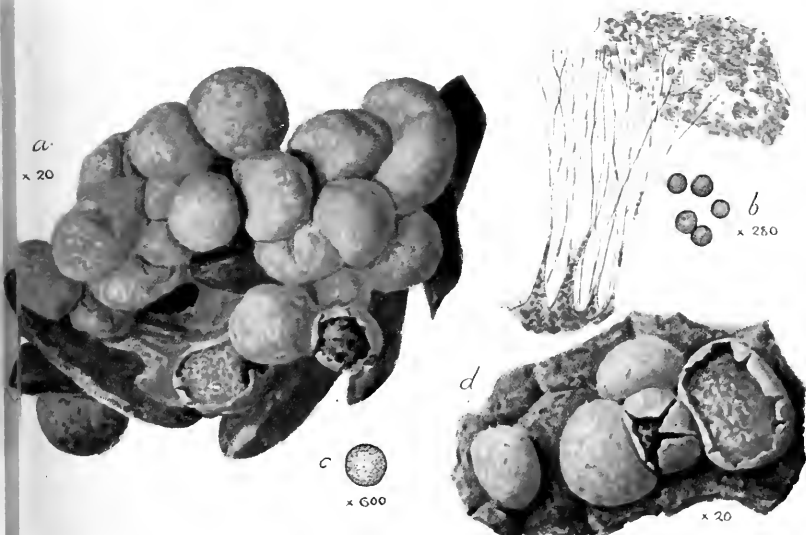
85. *DIDERMA GLOBOSUM* Pers.86. *DIDERMA RUGOSUM* Macbride





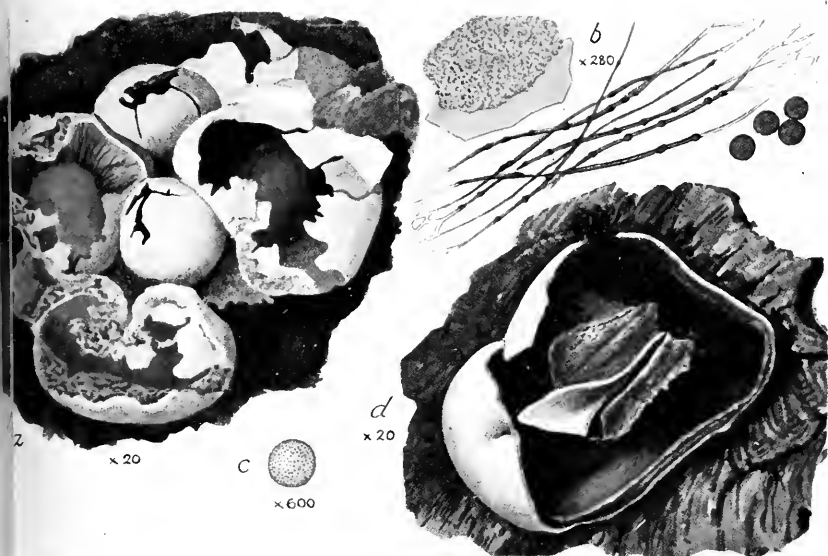
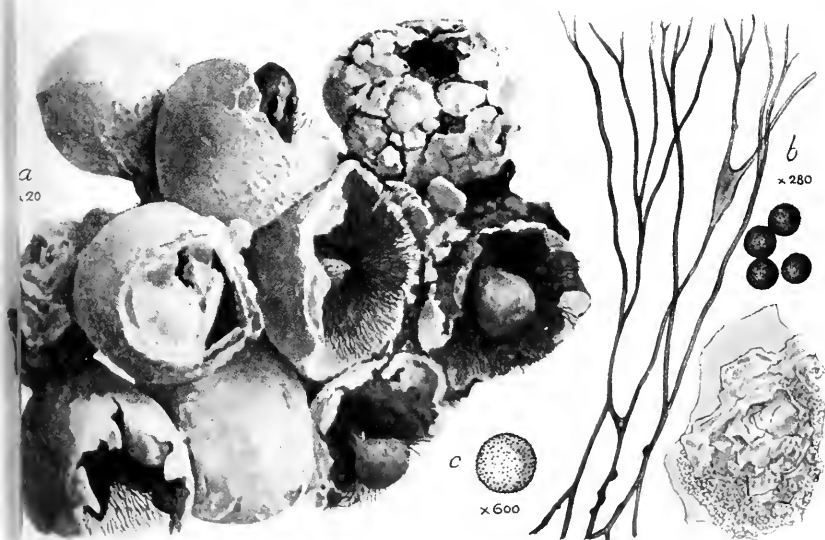


87. *a—c*, *DIDERMA TESTACEUM* Pers.;  
*d—f*, *D. SUBDICTYOSPERMUM* Lister

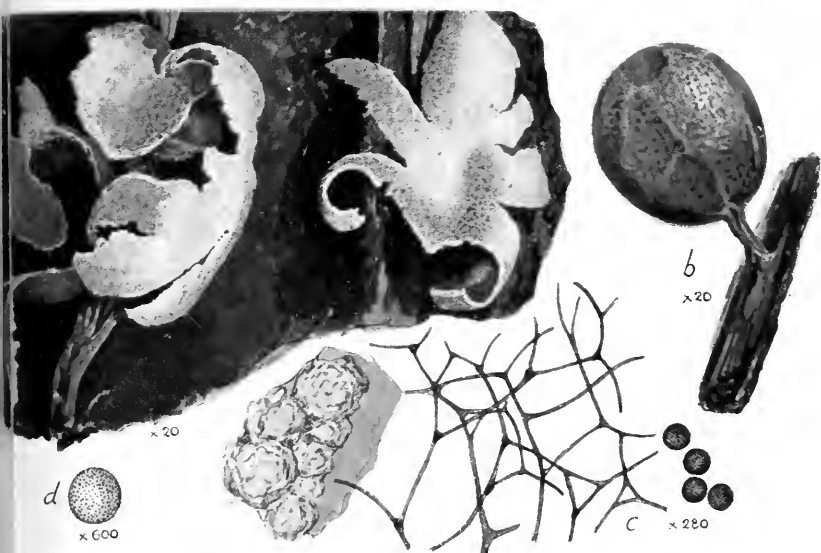
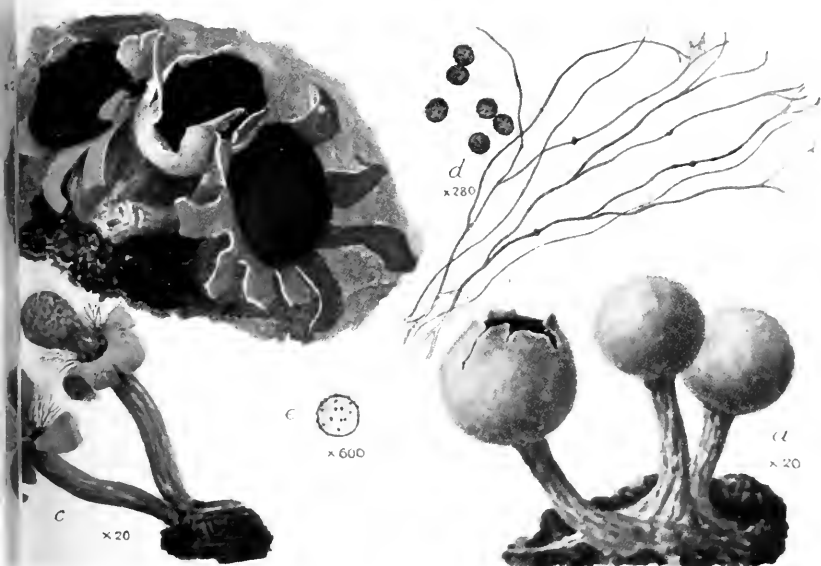


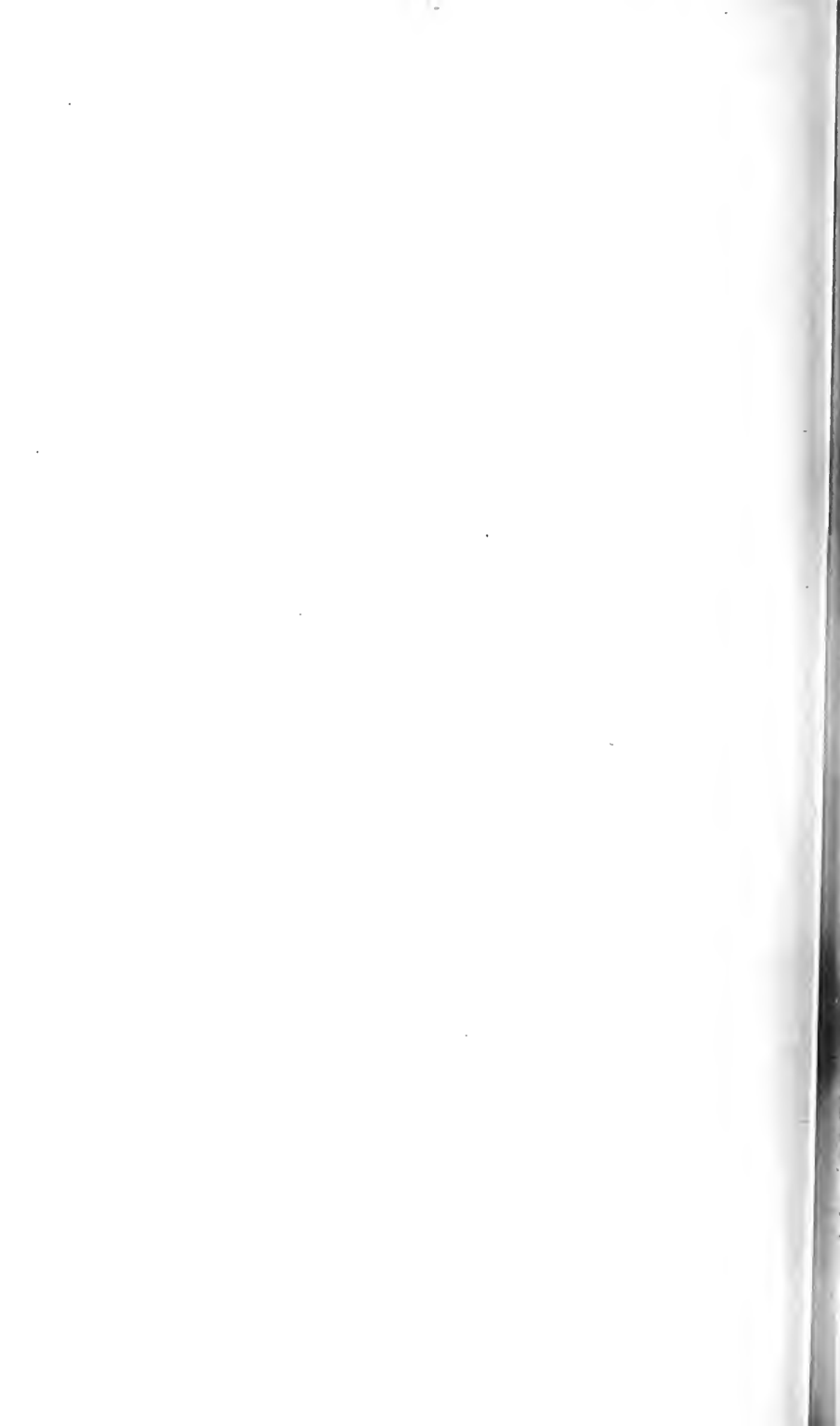
88. *DIDERMA SIMPLEX* Lister

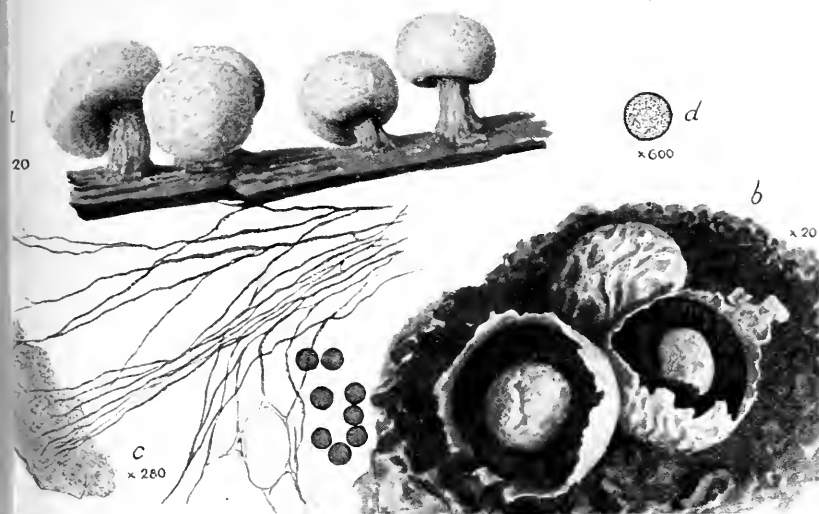


89. *DIDERMA NIVEUM* Macbride90. *DIDERMA NIVEUM* var. *LYALLII* Lister



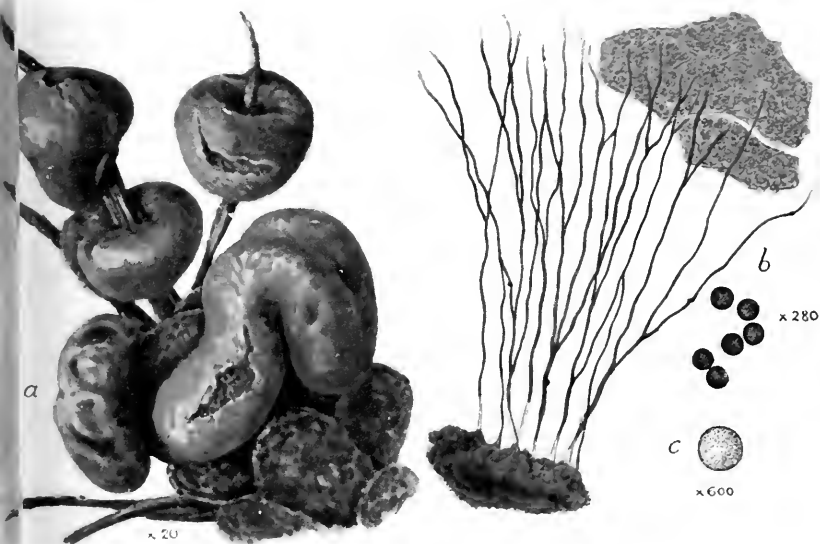
91. *DIDERMA TREVELYANI* Fries92. *DIDERMA FLORIFORME* Pers.



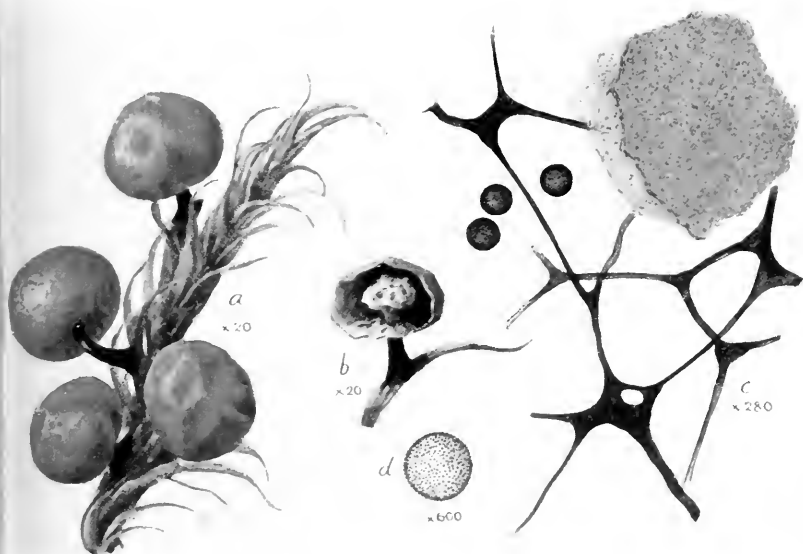
93. *DIDERMA RADIATUM* List.94. *a, b, DIDERMA RADIATUM* List.  
*c, d, D. ROANENSE* Macbride



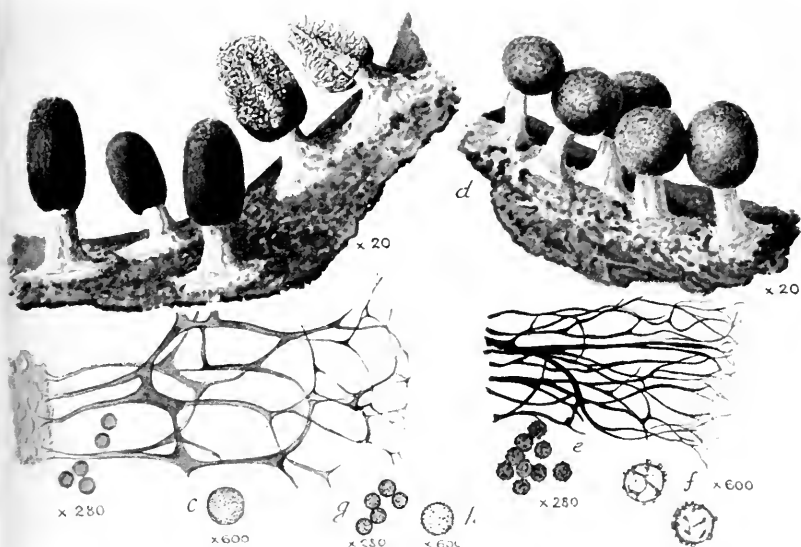


95. *DIDERMA SAUTERI* Macbride96. *DIDERMA OCHRACEUM* Hoffmann

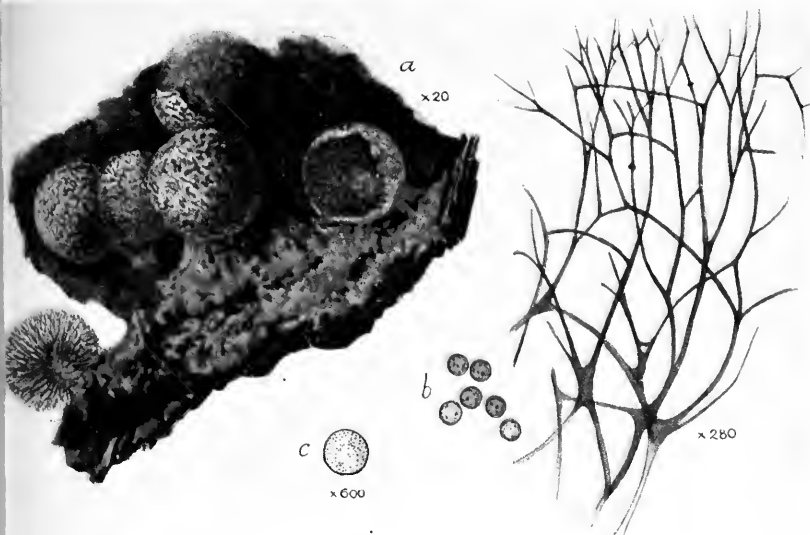


97. *DIDERMA ASTEROIDES* Lister98. *DIDERMA LUCIDUM* Berk. & Broome

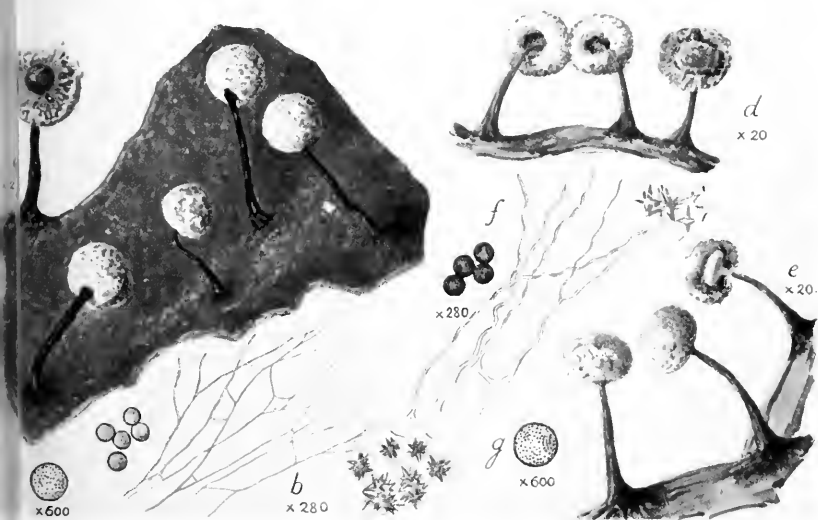


99. *a-c*, *DIACHLEA LEUCOPODA* Rest.*d-f*, *D. SPLENDENS* Peck*g, h*, *D. BULBILLOSA* Lister100. *DIACHLEA SUBSEVILIS* Peck





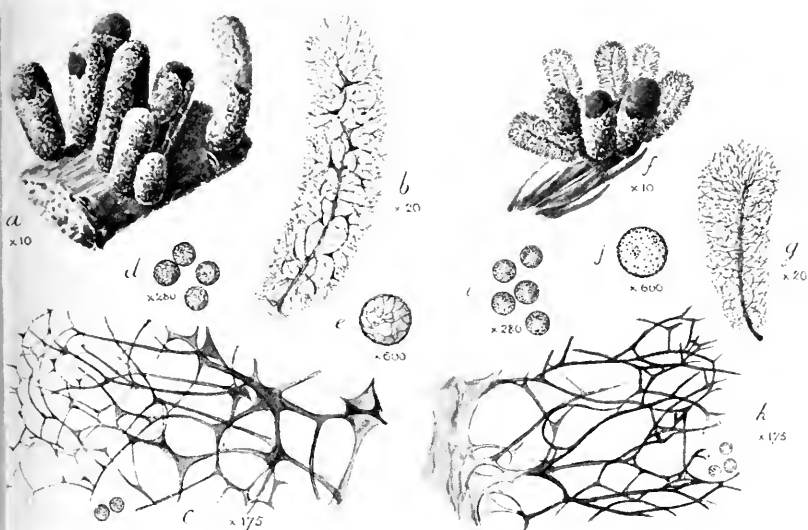
101. *DIACHLEA THOMASII* Rex



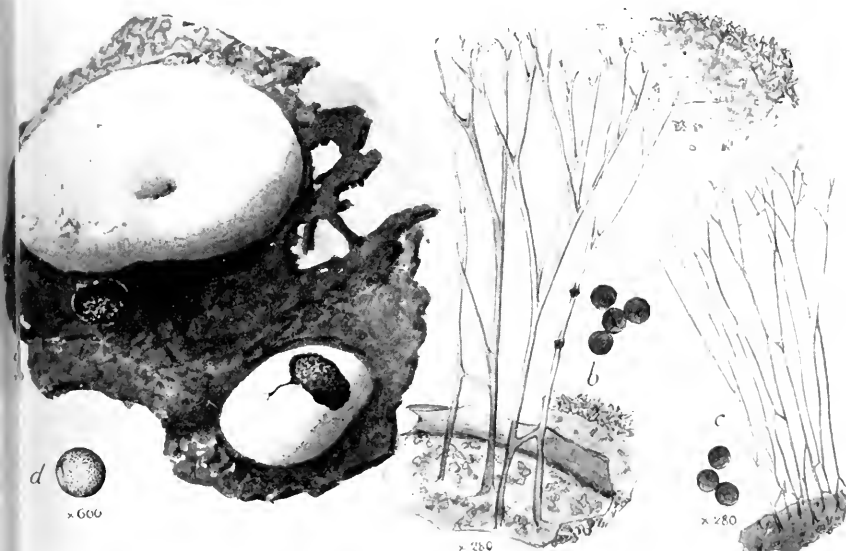
102. *DIDYMIUM NIGRIPES* Fries





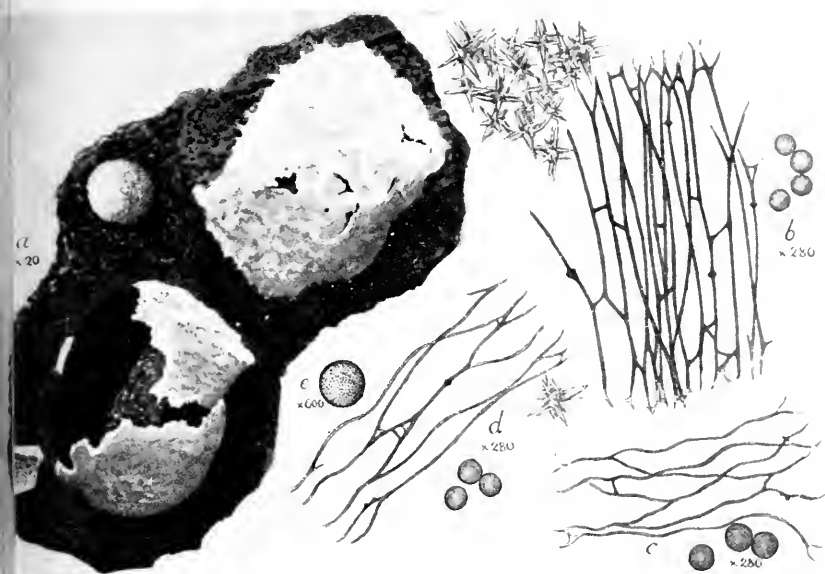


103. *a—e*, *DIACHLEA CYLINDRICA* Bilgram;  
*f—h*, *D. CAESPITOSA* Lister

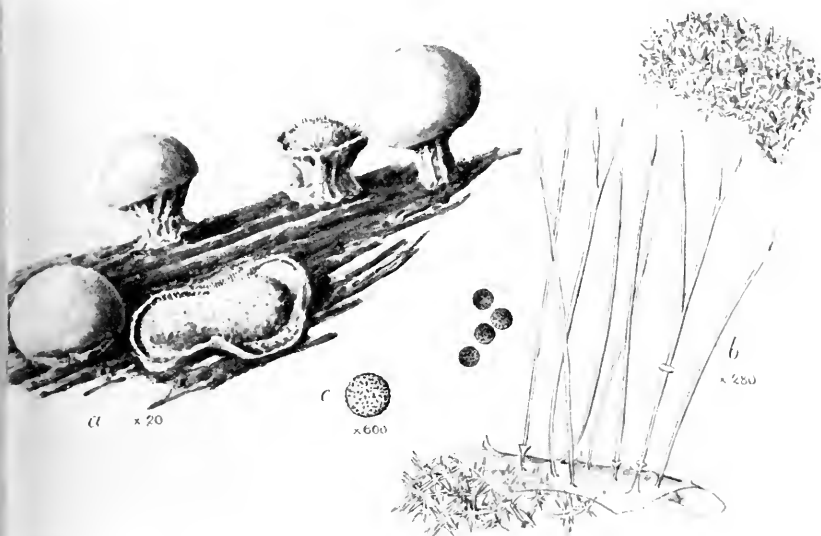


104. *DIDYMIUM DIFFORME* Duby



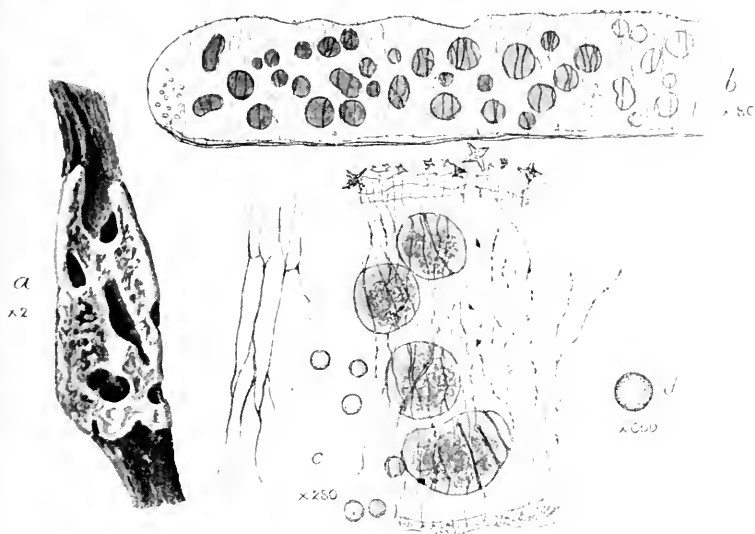


105. DIDYMIUM DUBIUM Rost

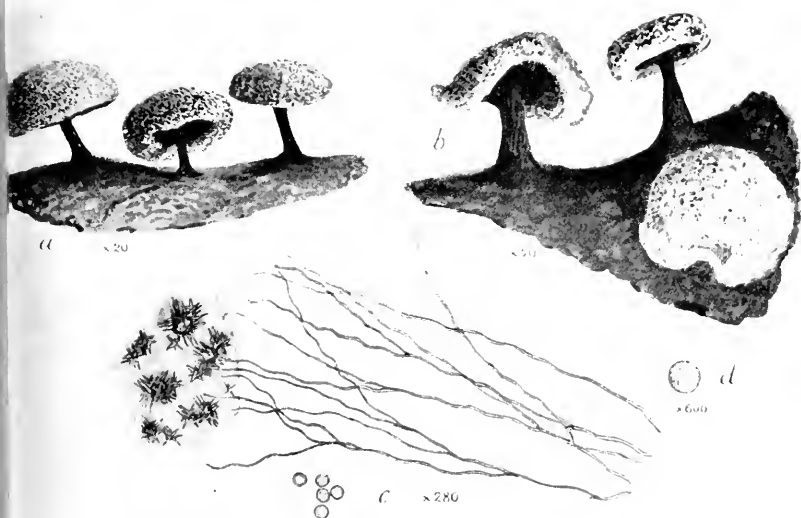


106. DIDYMIUM TROCHUS Lister



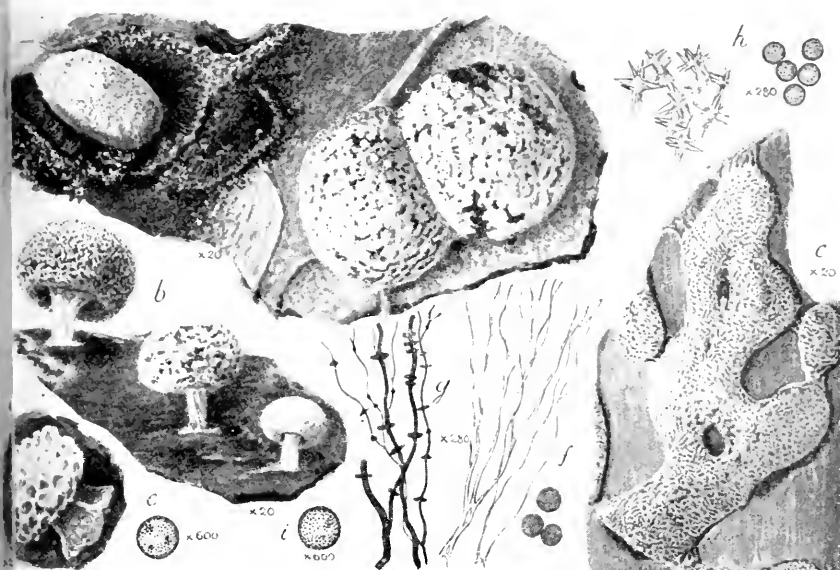


107. DIDYMIUM COMPLANATUM Rost.

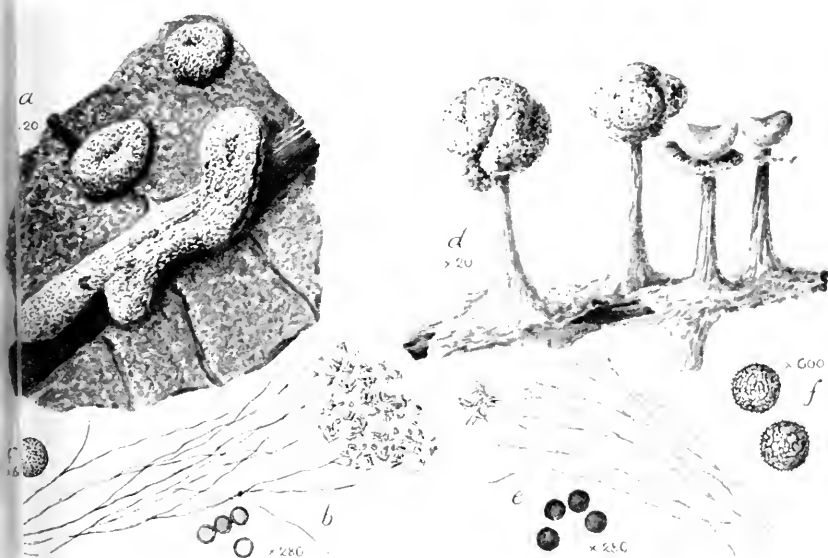


108 DIDYMIUM CLAVUS Rost.





109. DIDYMIUM SQUAMULOSUM Fries



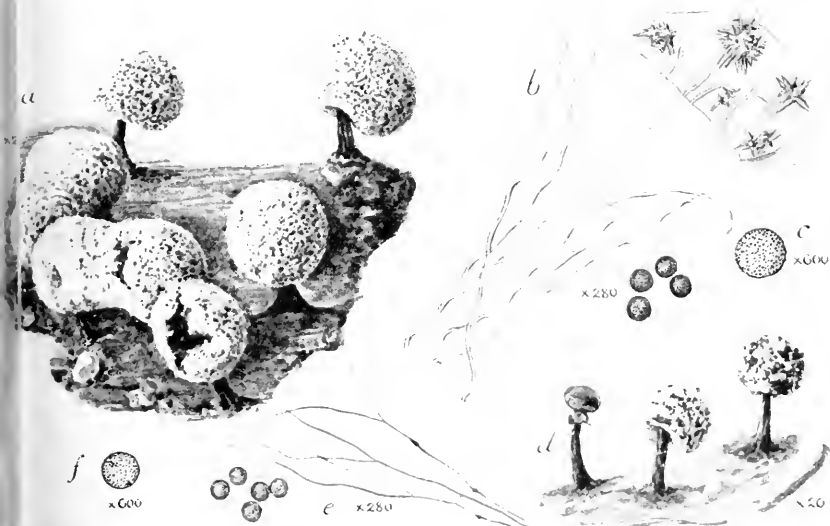
110. a—c, DIDYMIUM ANELLUS Morgan;  
d—f, D. INTERMEDIUM Schroeter





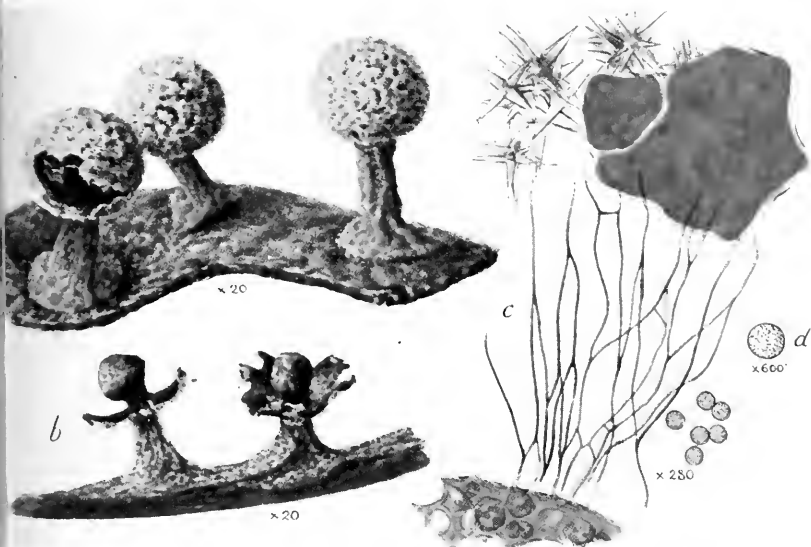


111. DIDYMIUM CRUSTACEUM Fries

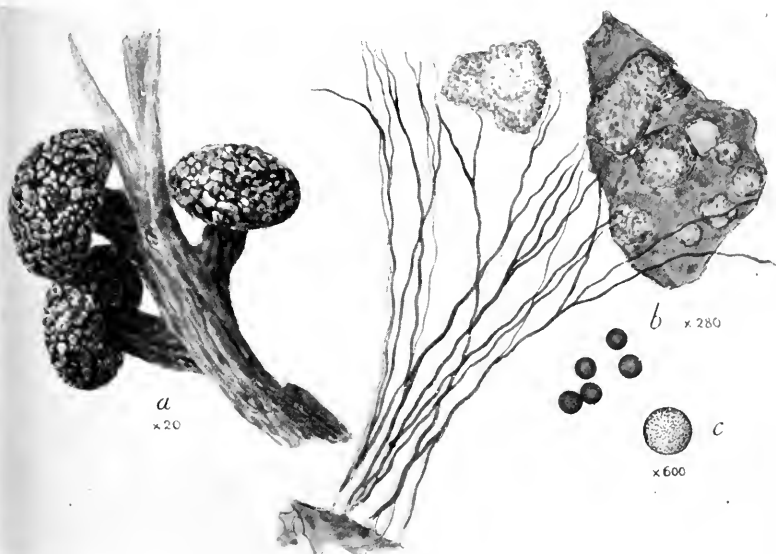


112. DIDYMIUM MELANOSPERMUM Macbride



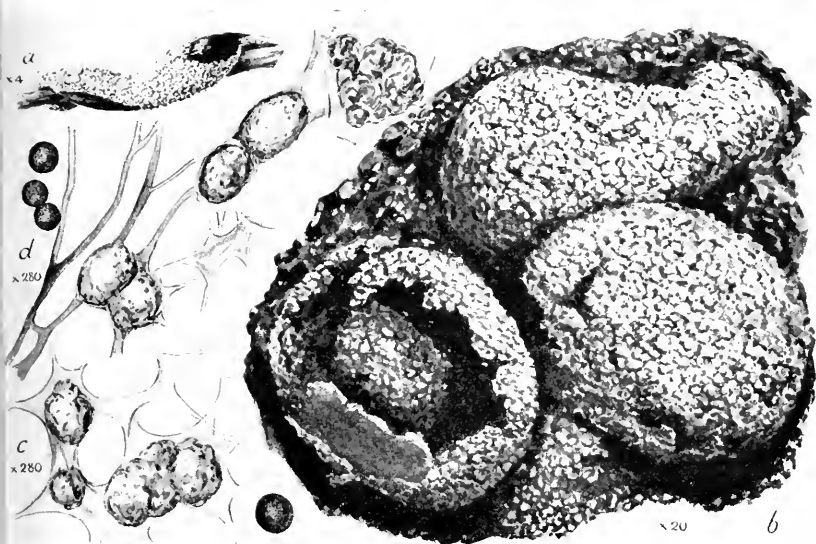
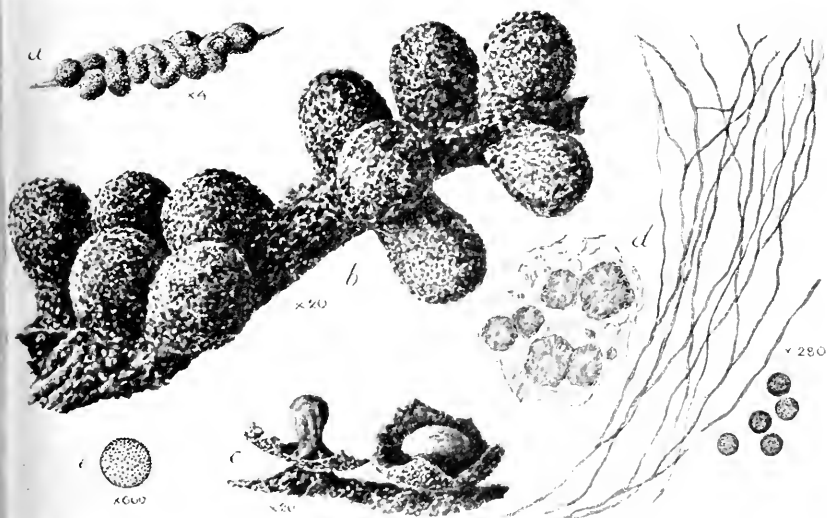


113. DIDYMIUM LEONINUM Berk. &amp; Br.

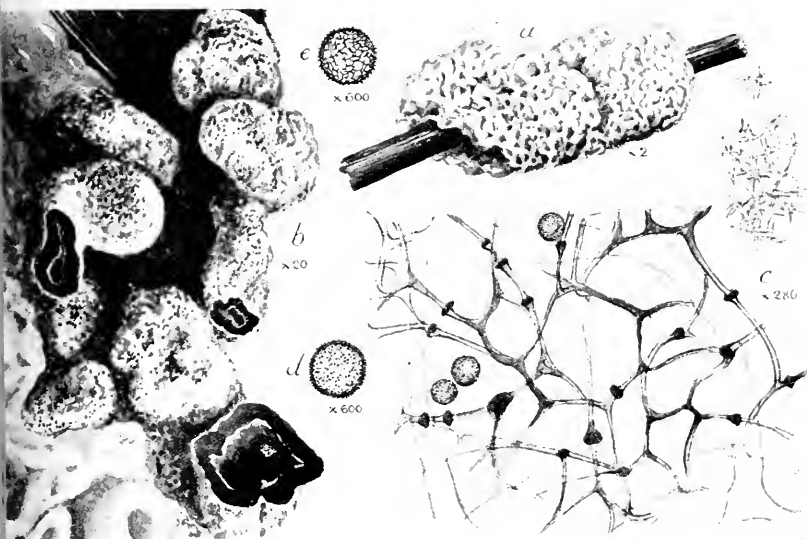


114. LEPIDODERMA TIGRINUM Rost.

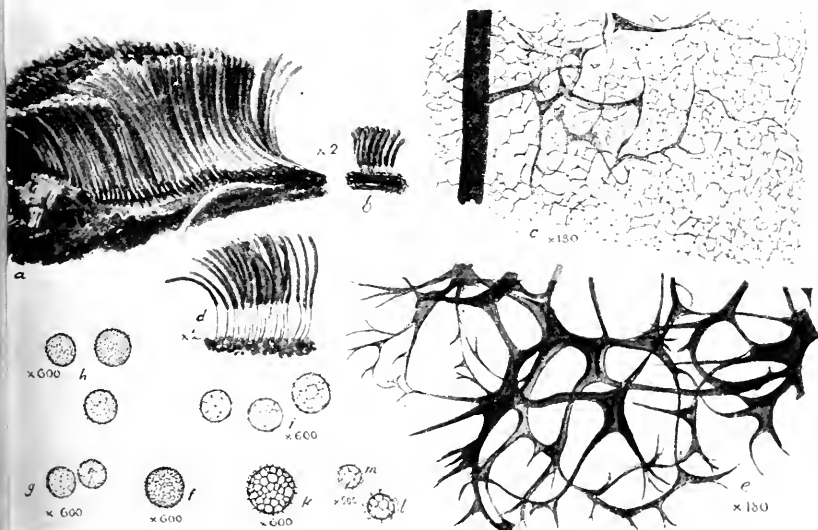


115. *LEPIDODERMA CARESTIANUM* Rost.116. *LEPIDODERMA CARESTIANUM* Rost.  
var. *CHAILLETHI* Lister





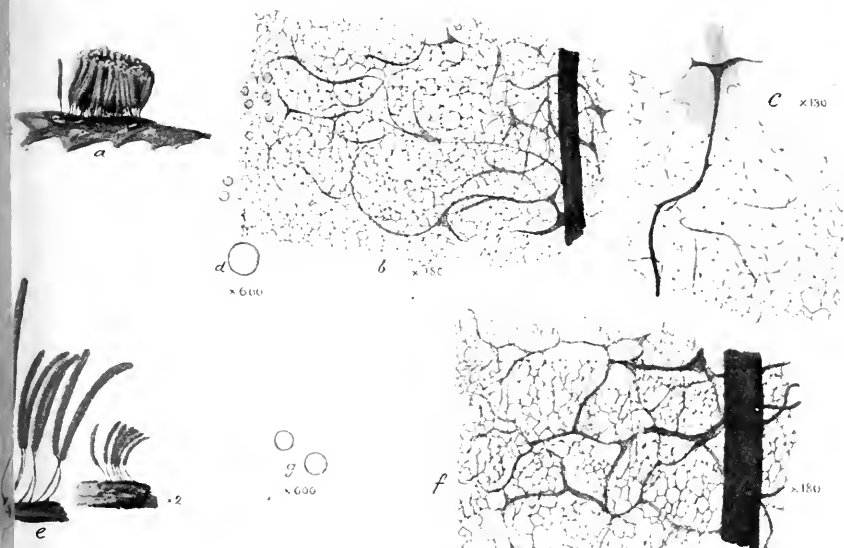
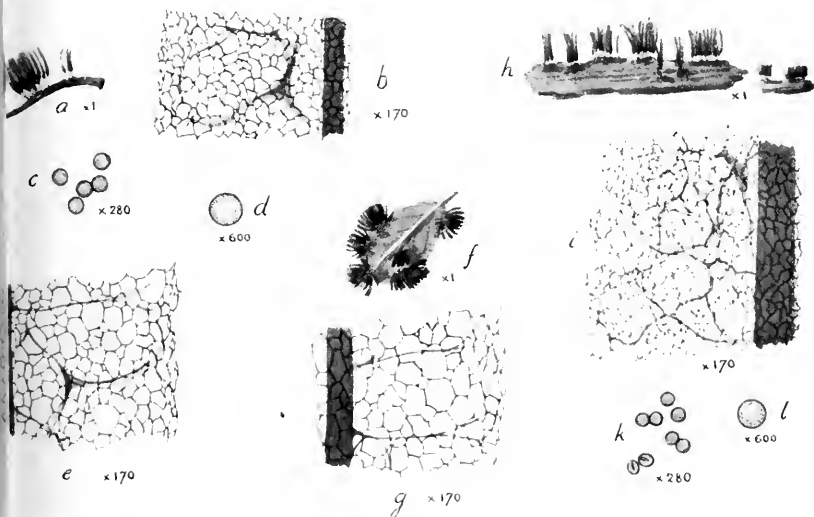
117. MUCILAGO SPONGIOSA Morgan



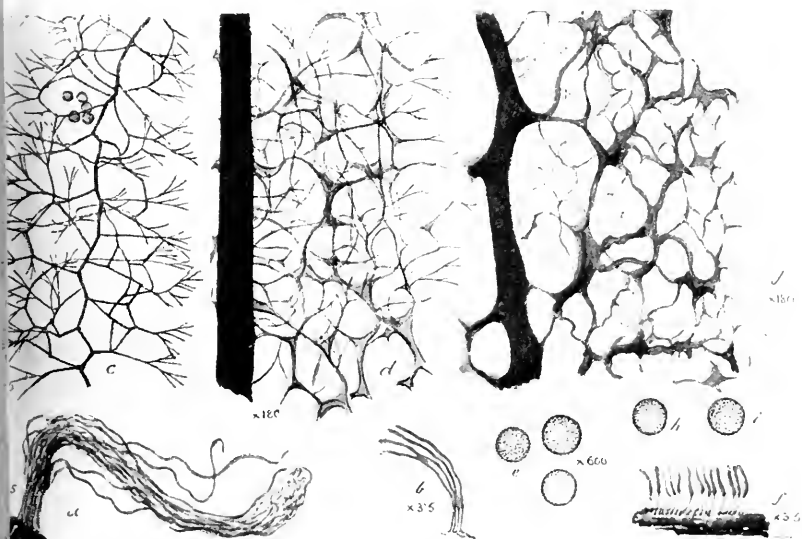
118. STEMONITIS FUSCA Roth



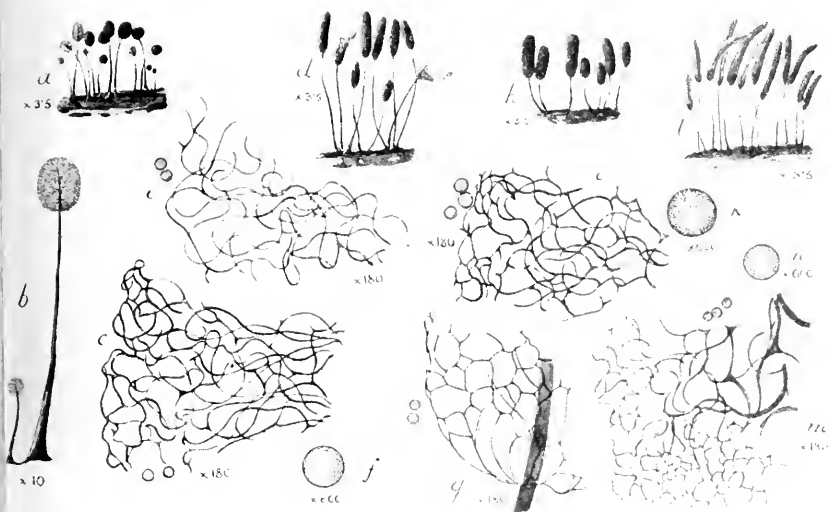


119. *a—d*, *STEMONITIS FLAVOGENITA* Jahn:*e—g*, *S. FERRUGINEA* Ehrenb.120. *a—g*, *STEMONITIS HERBATICA* Peck:*h—l*, *S. PALLIDA* Wingate.

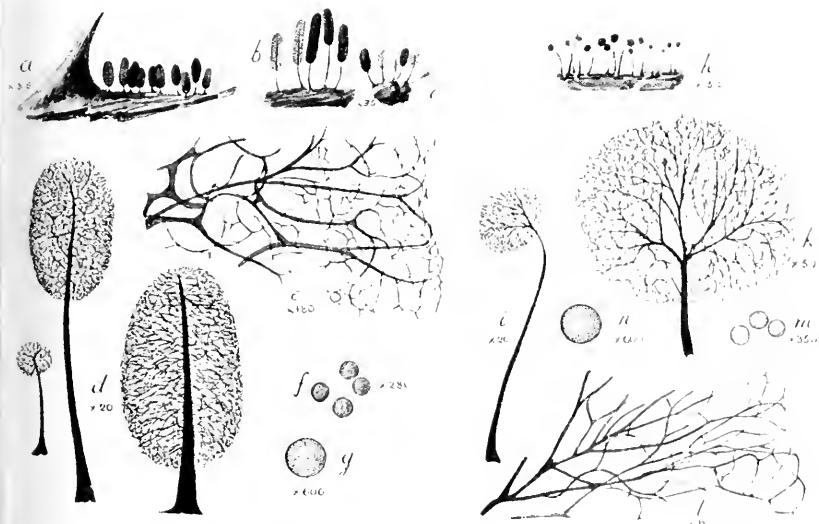


121. *a—i*, *STEMONITIS SPLENDENS* Rost.;*k*, *S. CONFLUENS* Cooke & Ellis122. *a—e*, *COMATRICHA LONGA* Peck;*f—i*, *C. IRREGULARIS* Rex





123. COMATRICA NIGRA Schroeter

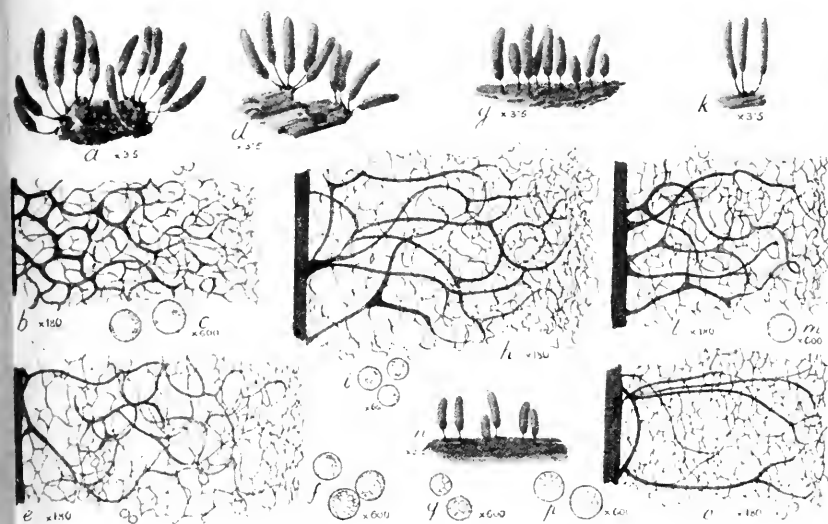


124. *a—g*, COMATRICHA LAXA Rost.;  
*h—n*, C. ELEGANS Lister

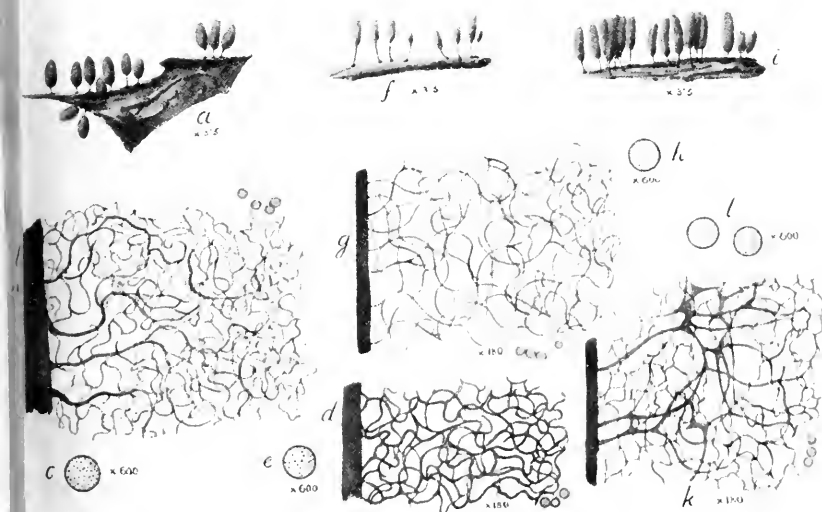
1

2

3



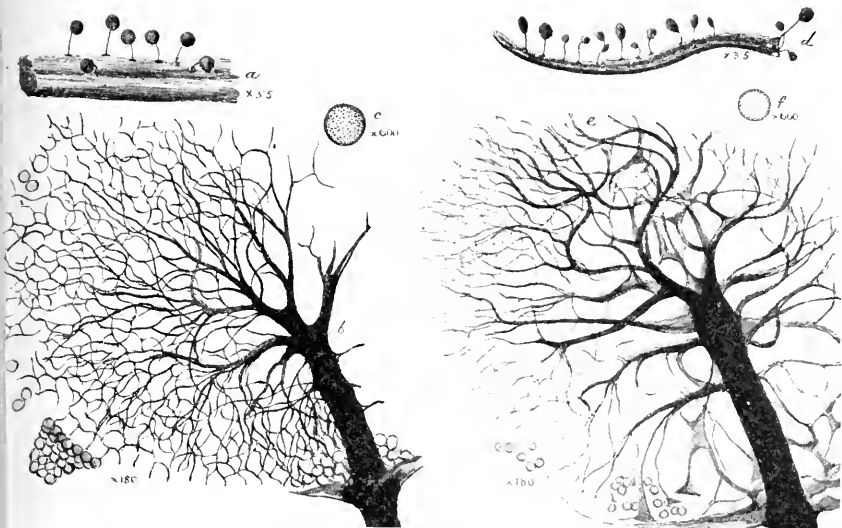
125. COMATRICHA TYPHOIDES Rost.



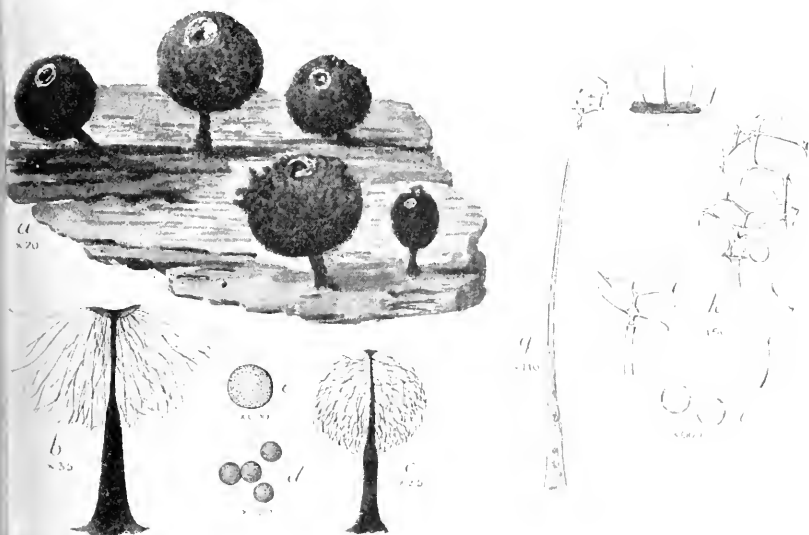
126. COMATRICHA PULCHELLA Rost.





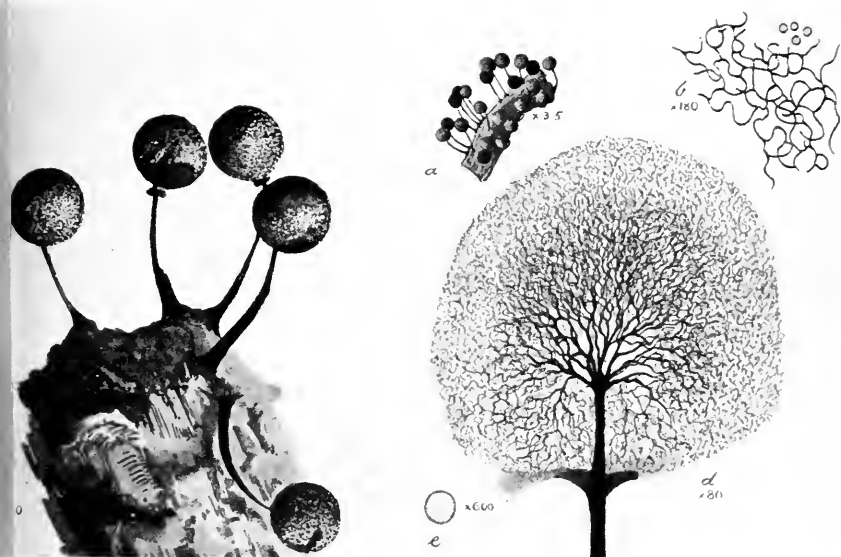


127. *a—c*, *COMATRICHA LURIDA* Lister;  
*d—f*, *C. RUBENS* Lister

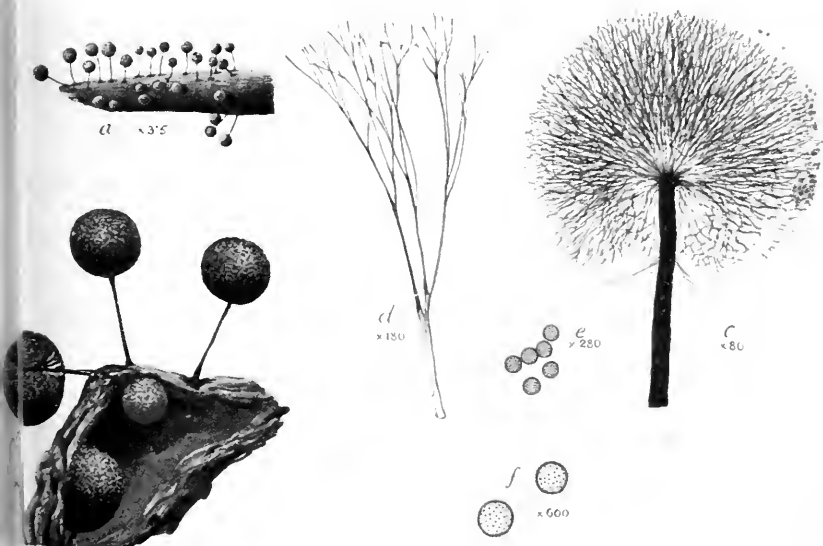


128. *a—e*, *ENERTHENEMA PAPILLATA* Rost.;  
*f—i*, *ECHINOSTELIUM MINUTUM* De Bary



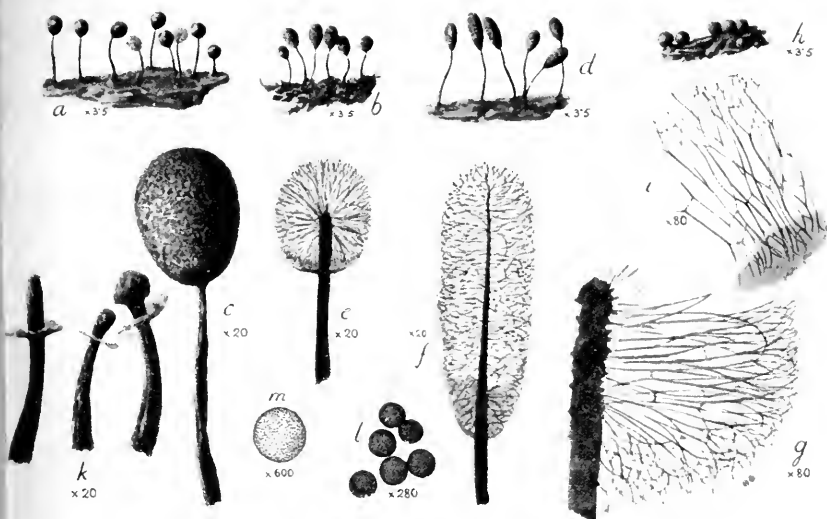
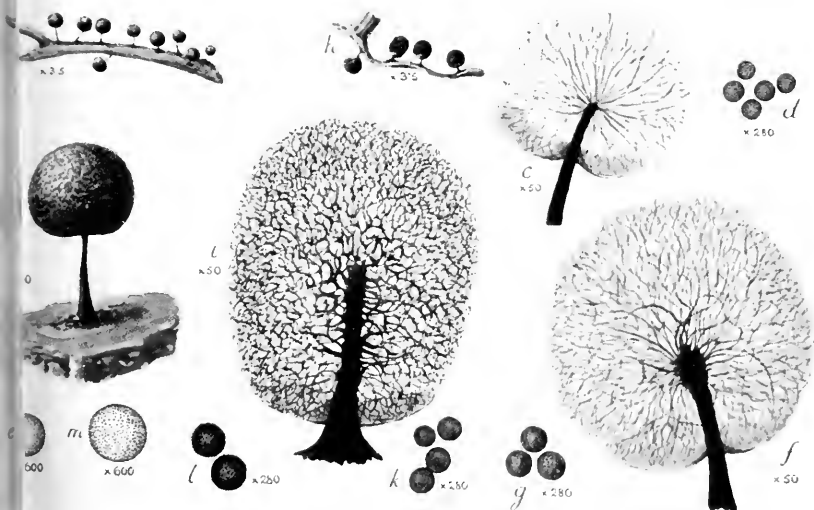


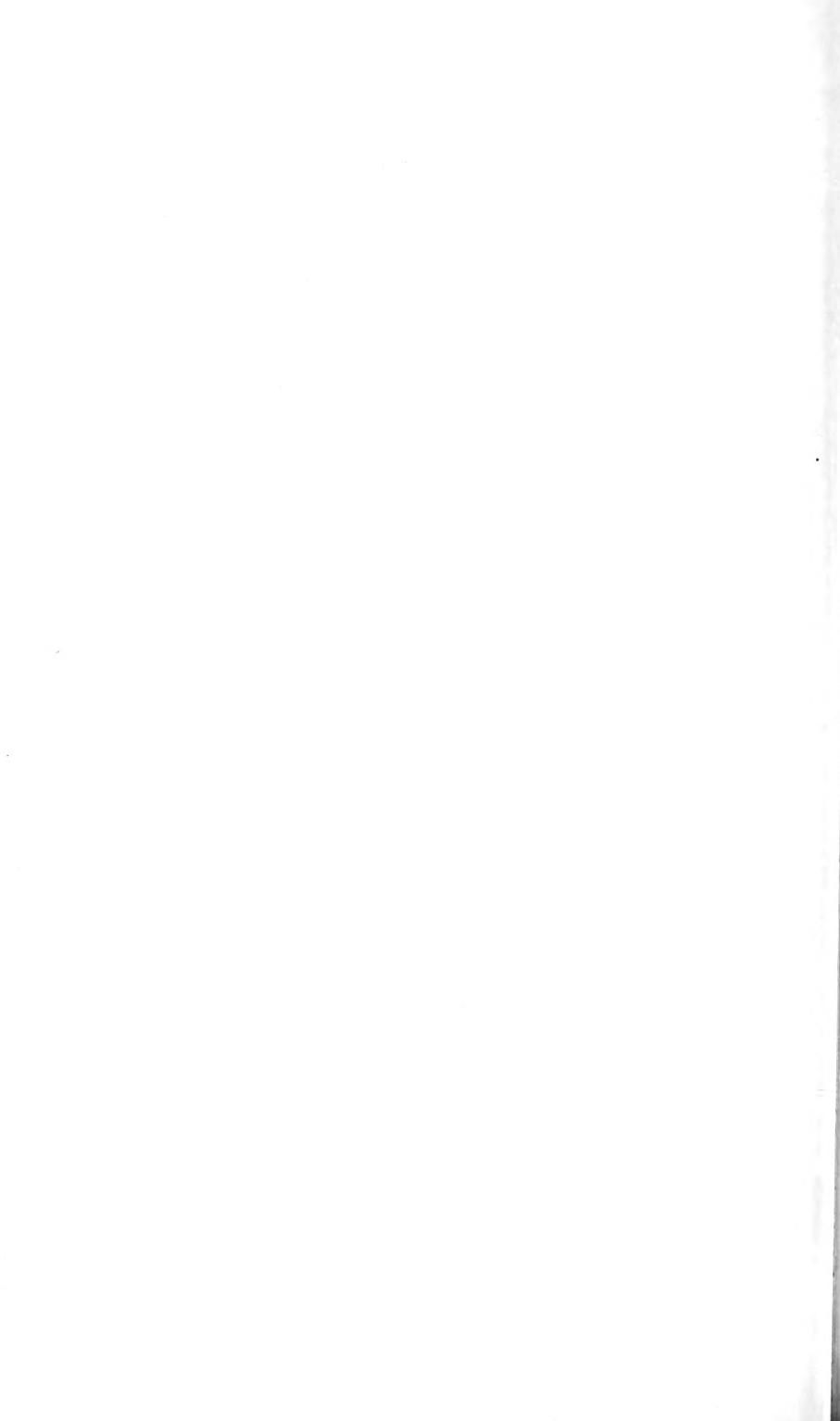
129. LAMPRODERMA ARCYRIONEMA Rost.

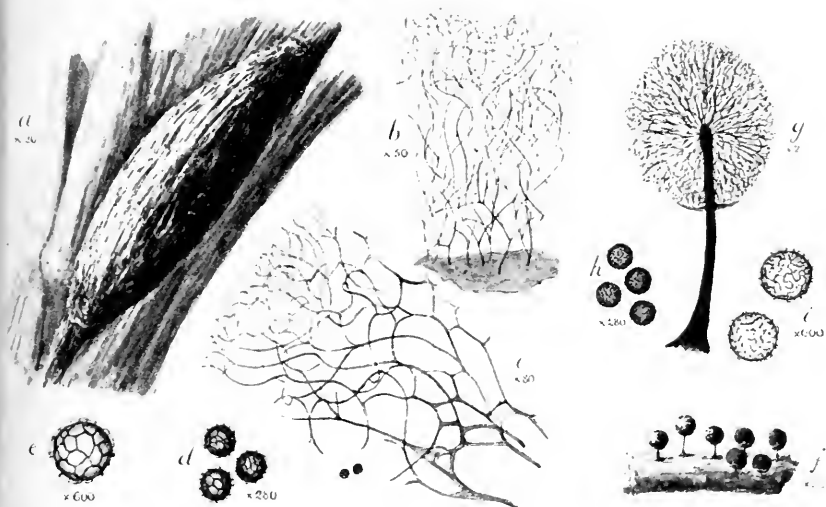


130. LAMPRODERMA SCINTILLANS Morgan

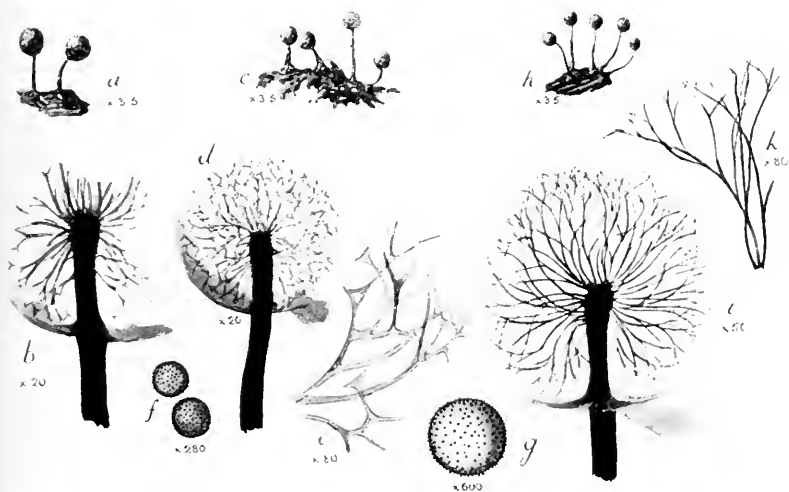


131. *LAMPRODERMA COLUMBINUM* Rost.132. *LAMPRODERMA VIOLACEUM* Rost.





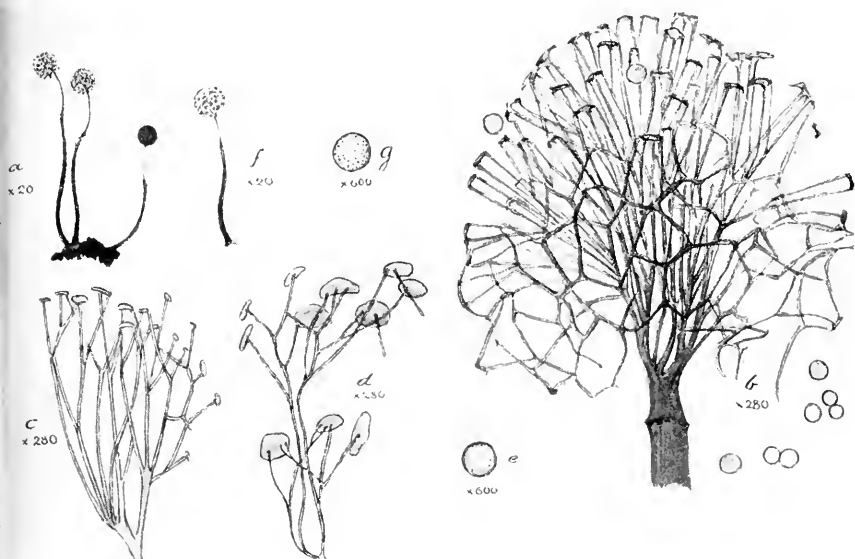
133. *a—e*, *LAMPRODERMA LYCOPODII* Raunkiaer;  
*f—i*, *L. VIOLACEUM* Rost. var. *DICTYOSPORUM* Lister



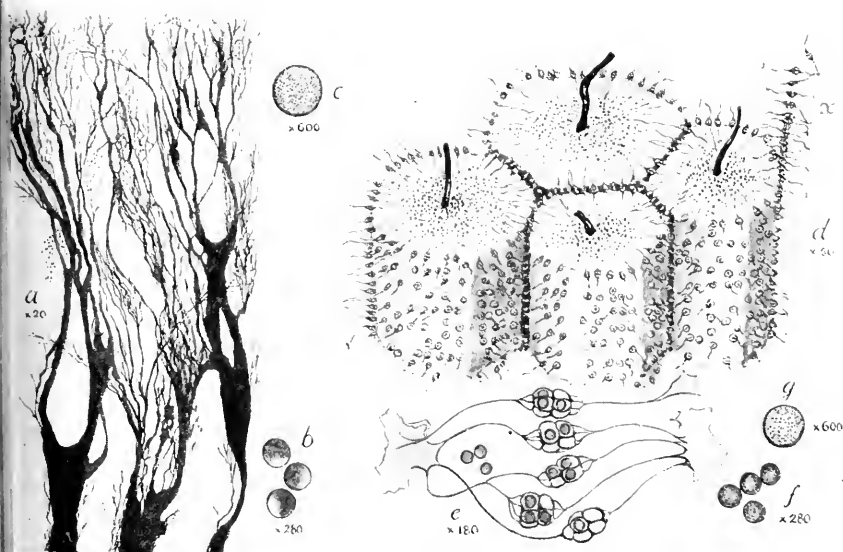
134. *LAMPRODERMA ECHINULATUM* Rost.



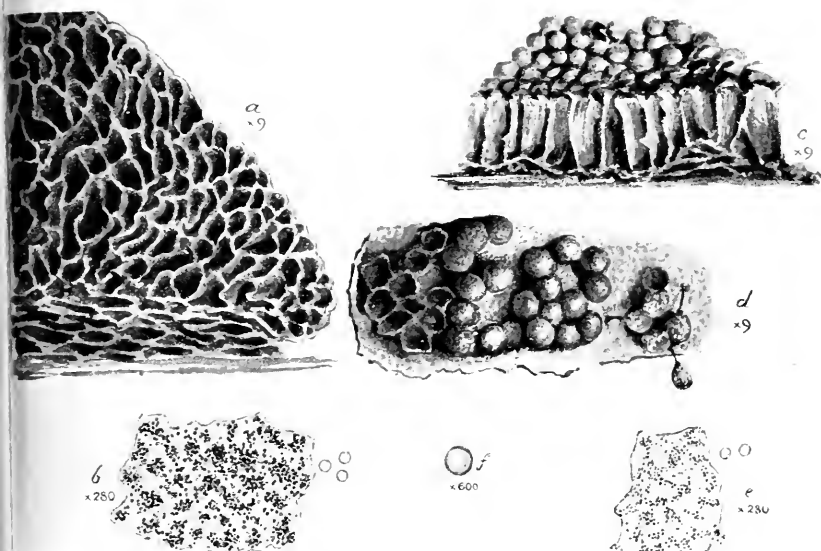




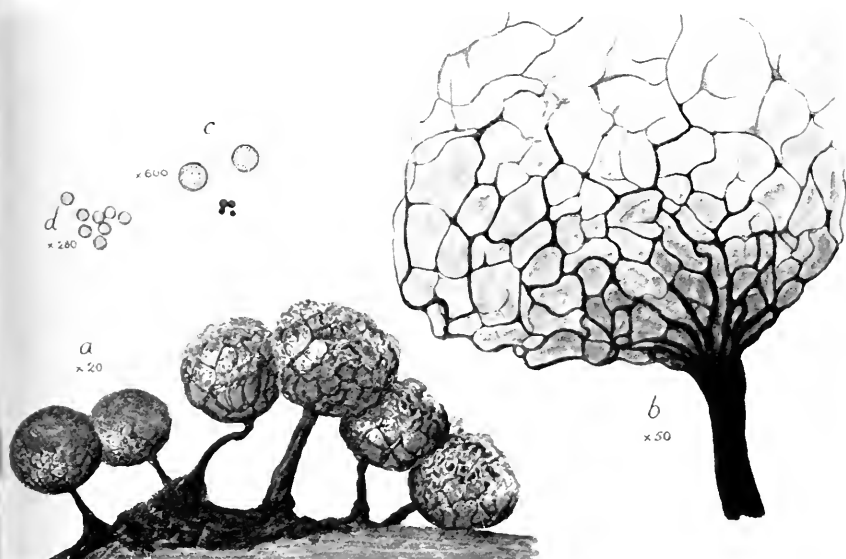
135. CLASTODERMA DEBARYANUM Blytt

136. a—c, AMAUROCHETE FULIGINOSA Macbride;  
d—g, Brefeldia maxima Rost.



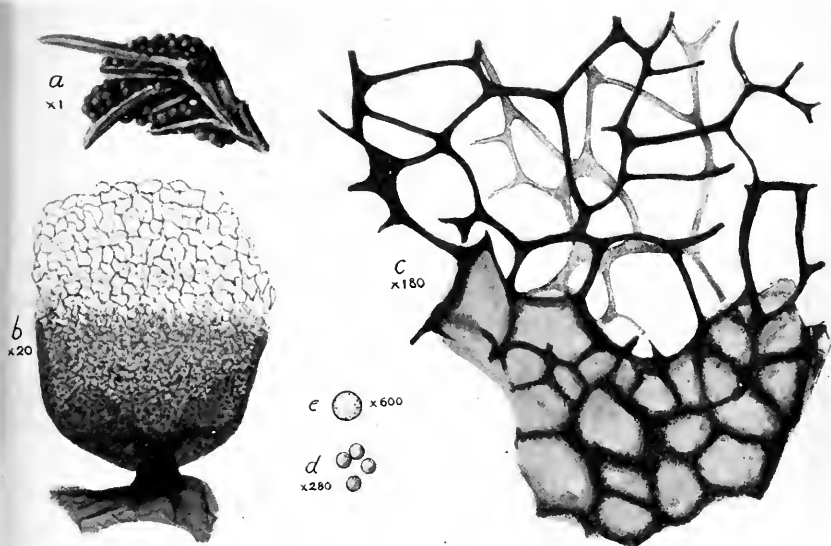


137. LINDBLADIA EFFUSA Rost.

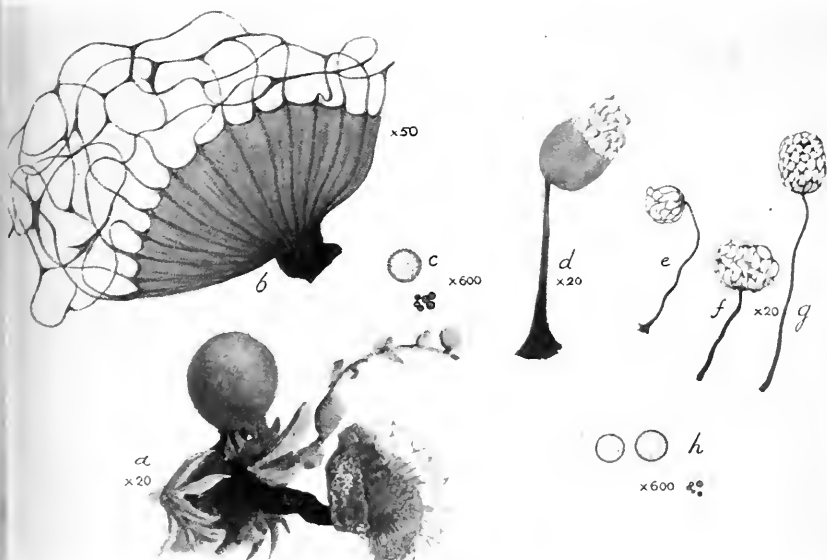


138. CRIBRARIA ARGILLACEA Pers.



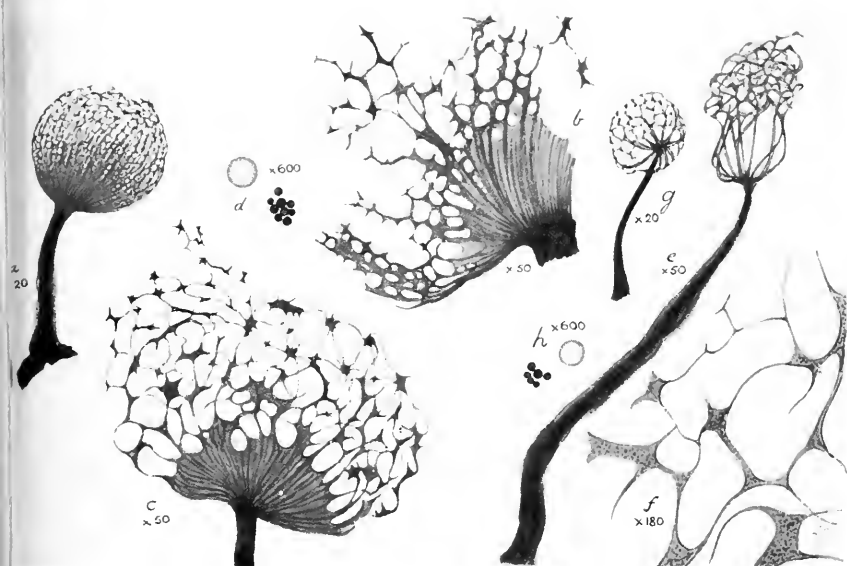


139. CRIBRARIA RUBIGINOSA Fries



140. a—c. CRIBRARIA RUFA Rost.:  
d—h. C. MINUTISSIMA Schwein.





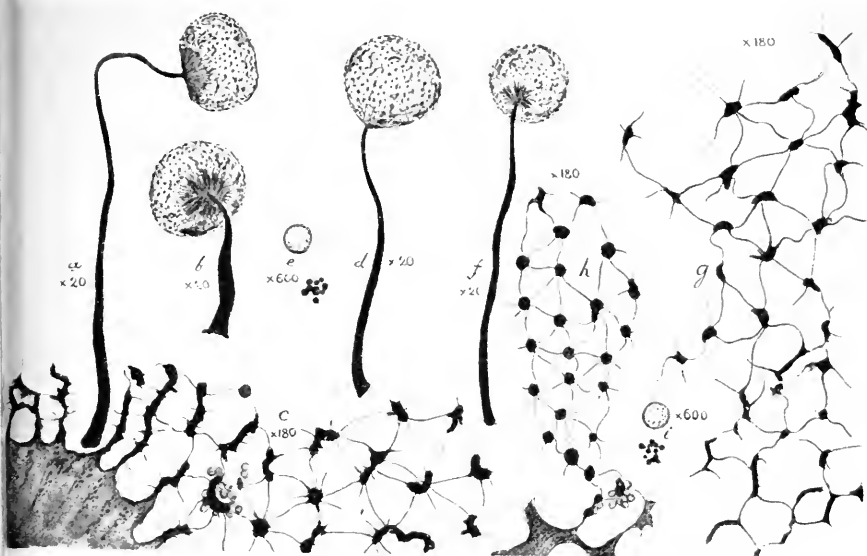
141. *a—d*, *CRIBRARIA MACROCARPA* Schrad.;  
*e—g*, *C. SPLENDENS* Pers.



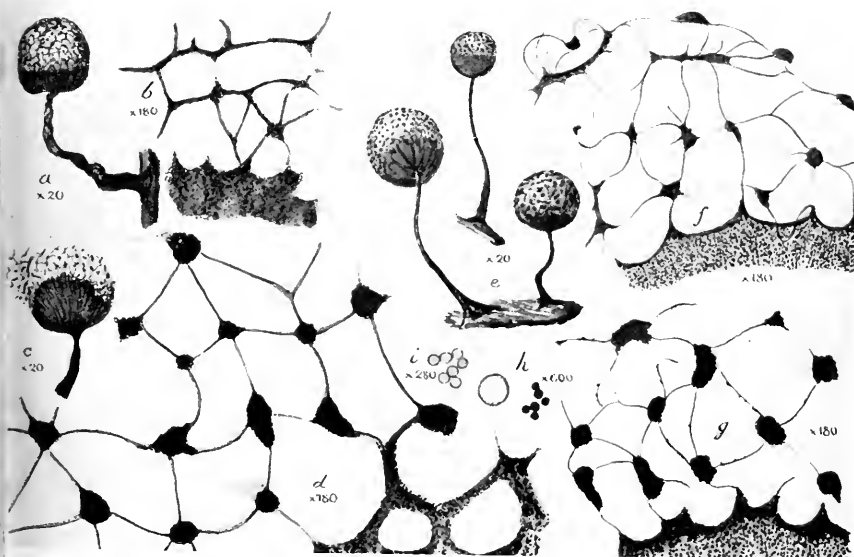
142. *CRIBRARIA AURANTIACA* Schrad.





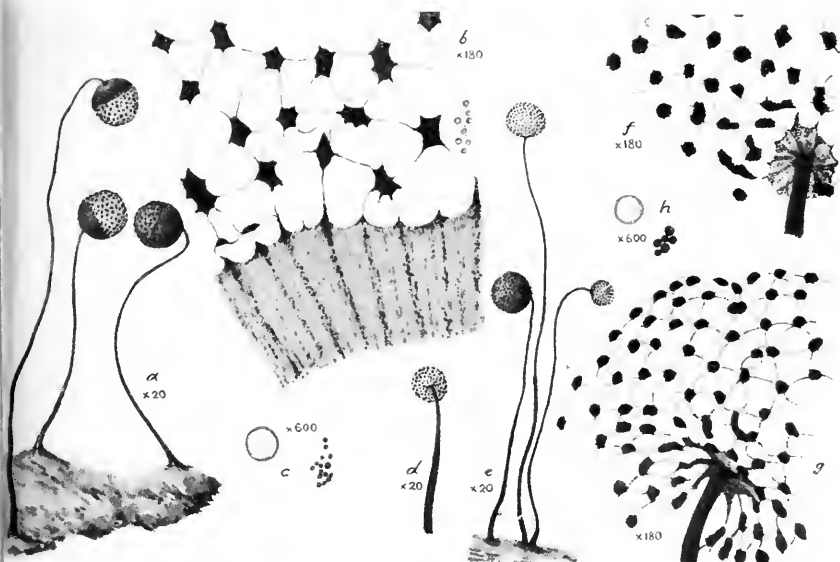


143. *a—e*, *CRIBRARIA INTRICATA* Schrader;  
*f—i*, *C. TENELLA* Schrader

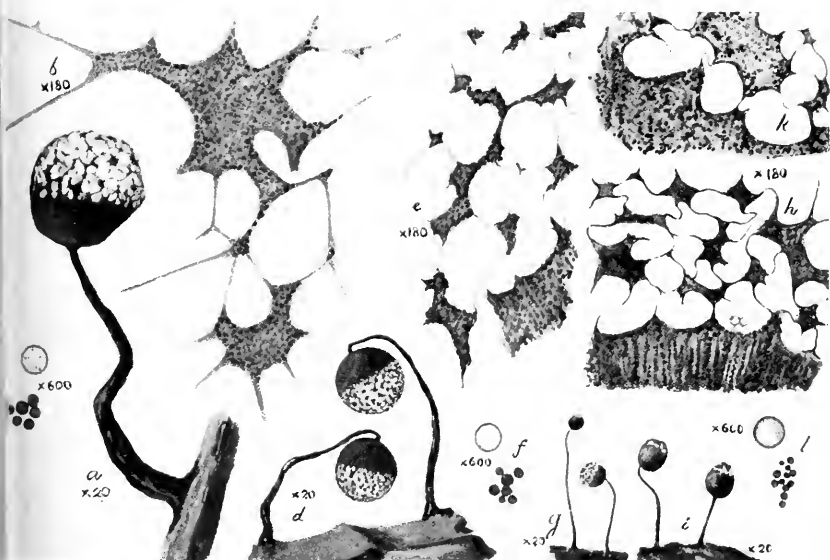


144 *CRIBRARIA PYRIFORMIS* Schrader



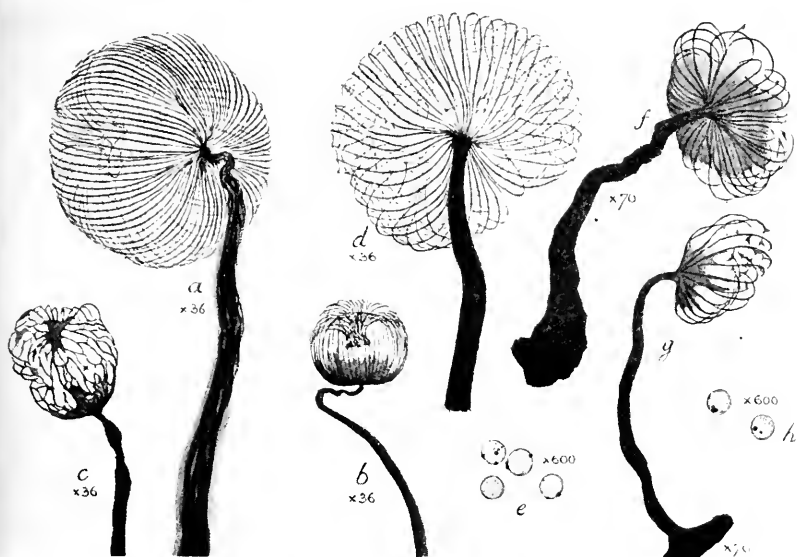
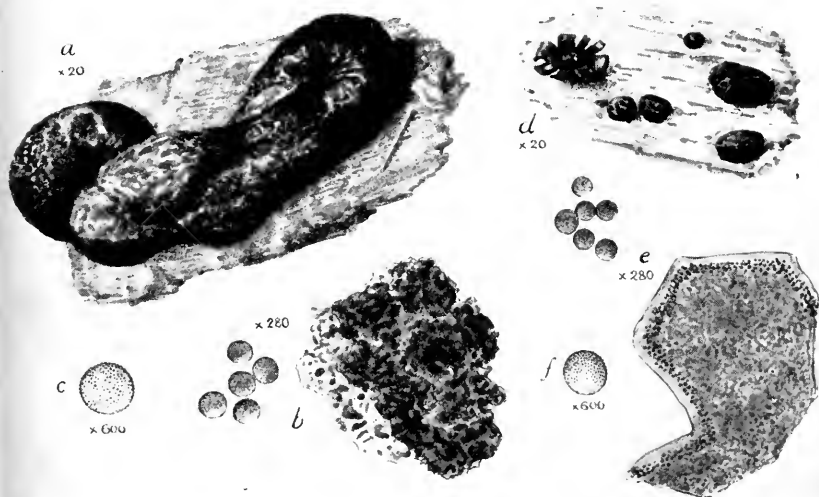


145. *a—c*, *CRIBRARIA LANGUESCENS* Rex  
*d—h*, *C. MICROCARPA* Schrader

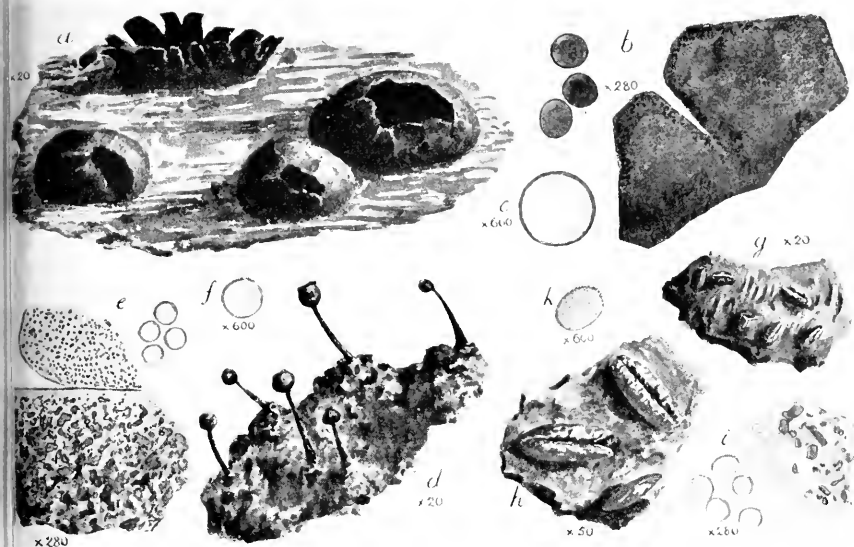


146. *a—e*, *CRIBRARIA PURPUREA* Schrader  
*d—f*, *C. ELEGANS* Berk. & Curt.  
*g—i*, *C. VIOLECEA* Rex

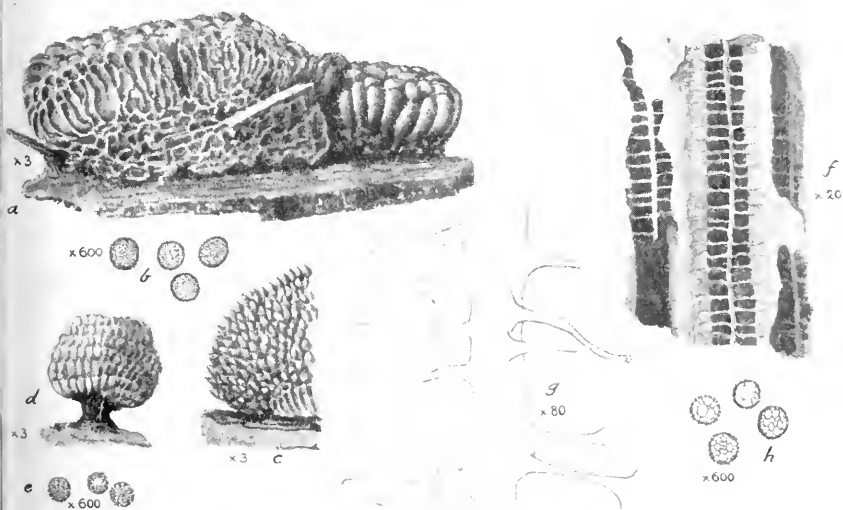


147. *Dictydium cancellatum* Macbride148. *a—c*, *Licea flexuosa* Pers.;  
*d—f*, *L. minima* Fries





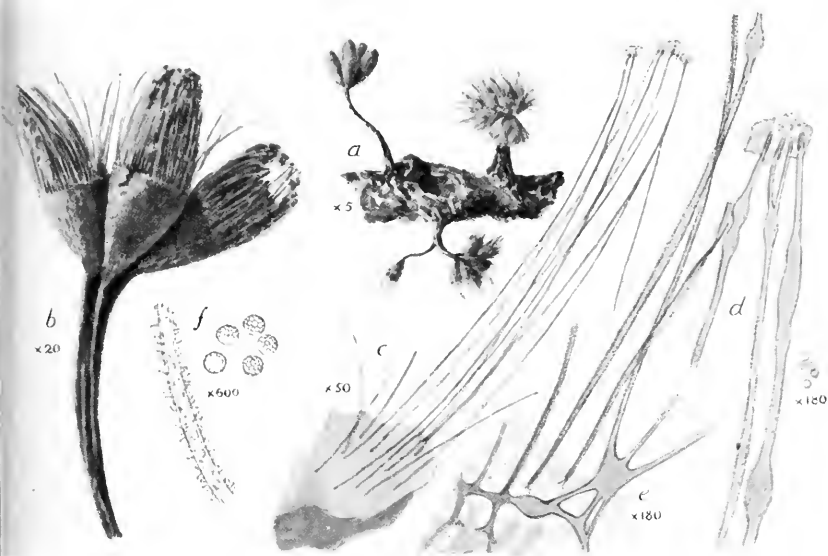
149. *a—c*, *LICEA PUSILLA* Schrader;  
*d—f*, *ORCADELLA OPERCULATA* Wingate;  
*g—k*, *LICEA BIFORIS* Morgan



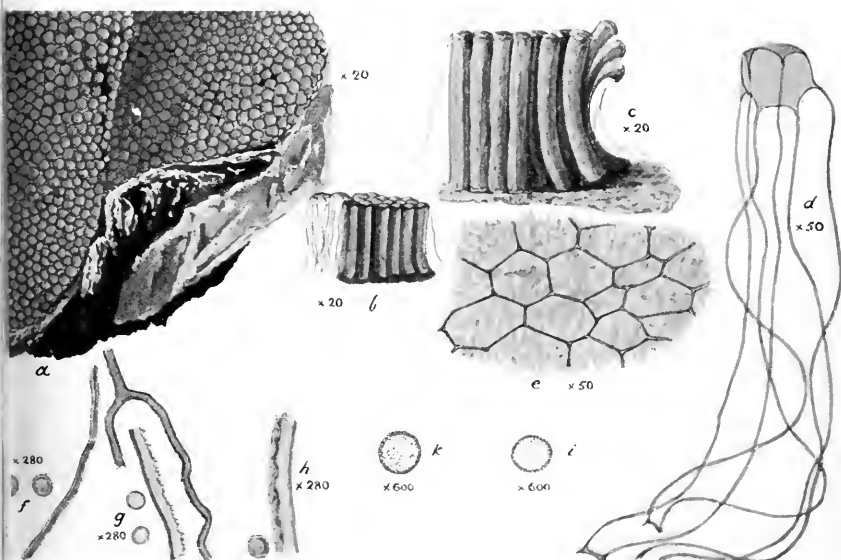
150. *a—c*, *TUBIFERA FERRUGINOSA* Gmelin,  
*d—e*, *T. STIPITATA* Macbride;  
*f—h*, *T. CASPARYI* Macbride





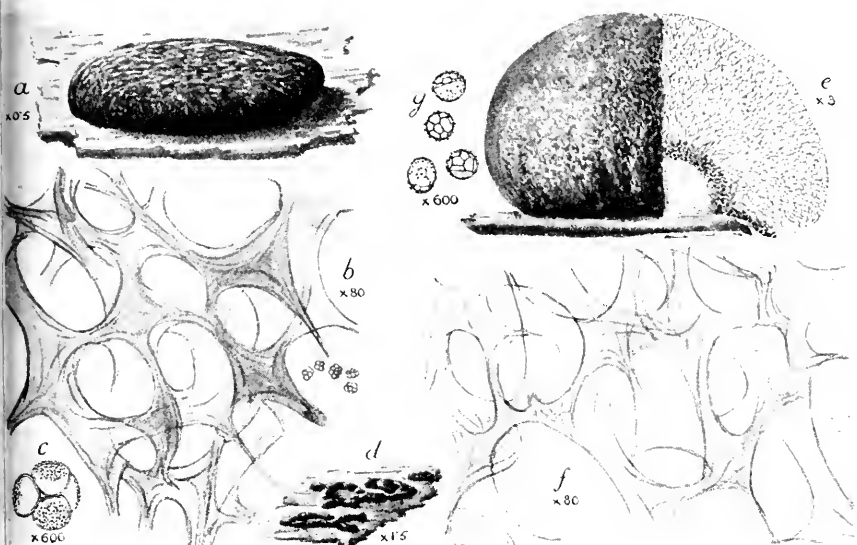


151. ALWISIA BOMBARDA Berk. &amp; Broome

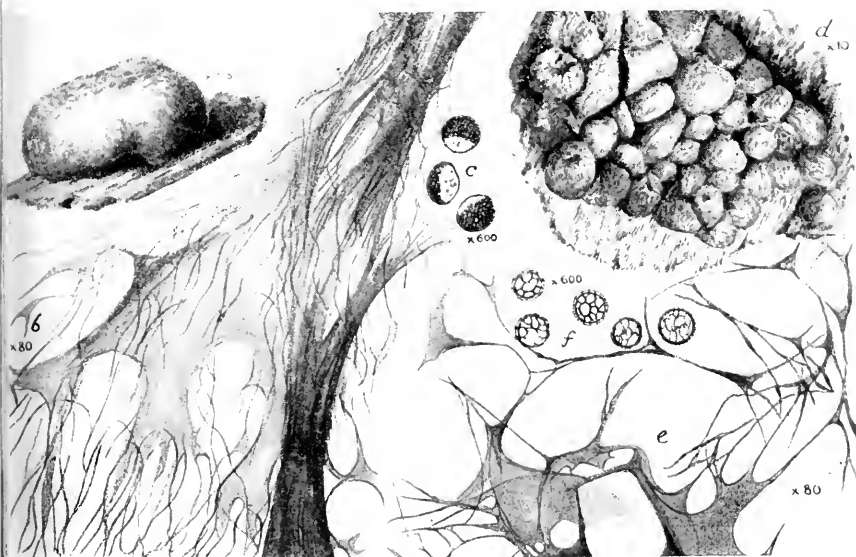


152. DICTYDLETHALIUM PLUMBEUM Rost.



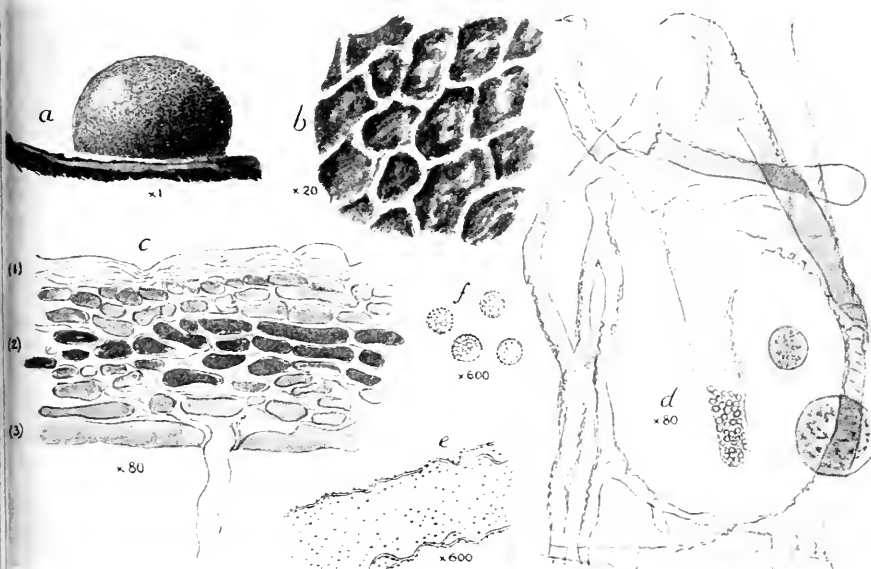
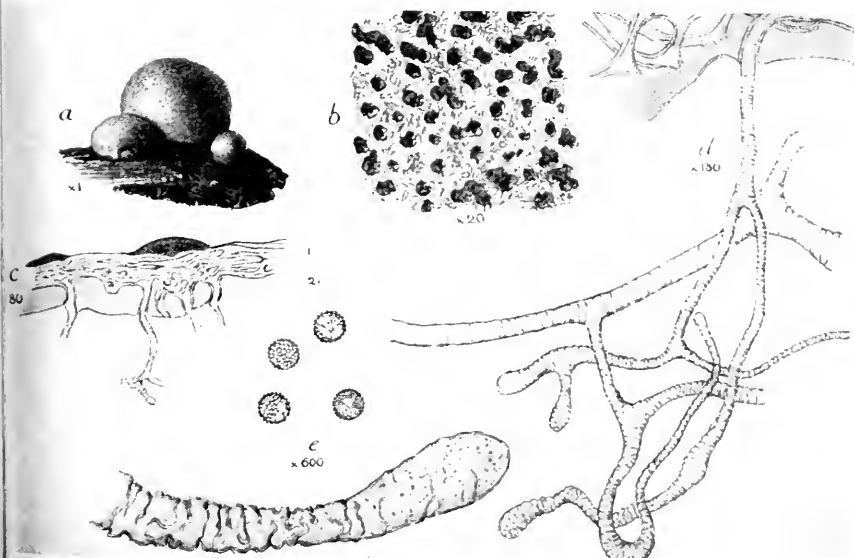


153. a—d, *ENTERIDIUM OLIVACEUM* Ehrenb. ;  
e—g, *E. ROZEANUM* Wingate



154. a—c, *RETICULARIA LYCOPERDON* Bull. ;  
d—f, *LICEOPSIS LOBATA* Torrend

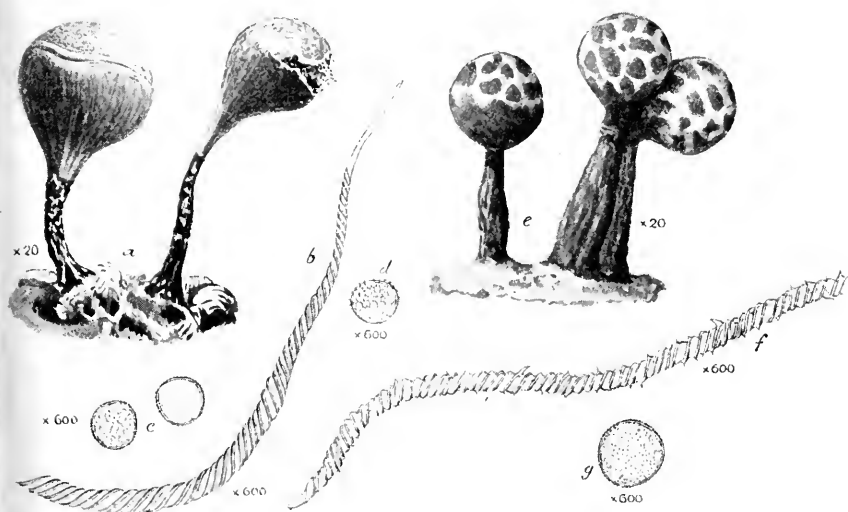


155. *LYCOGALA FLAVOFUSCUM* Rost.156. *LYCOGALA EPIDENDRUM* Fries

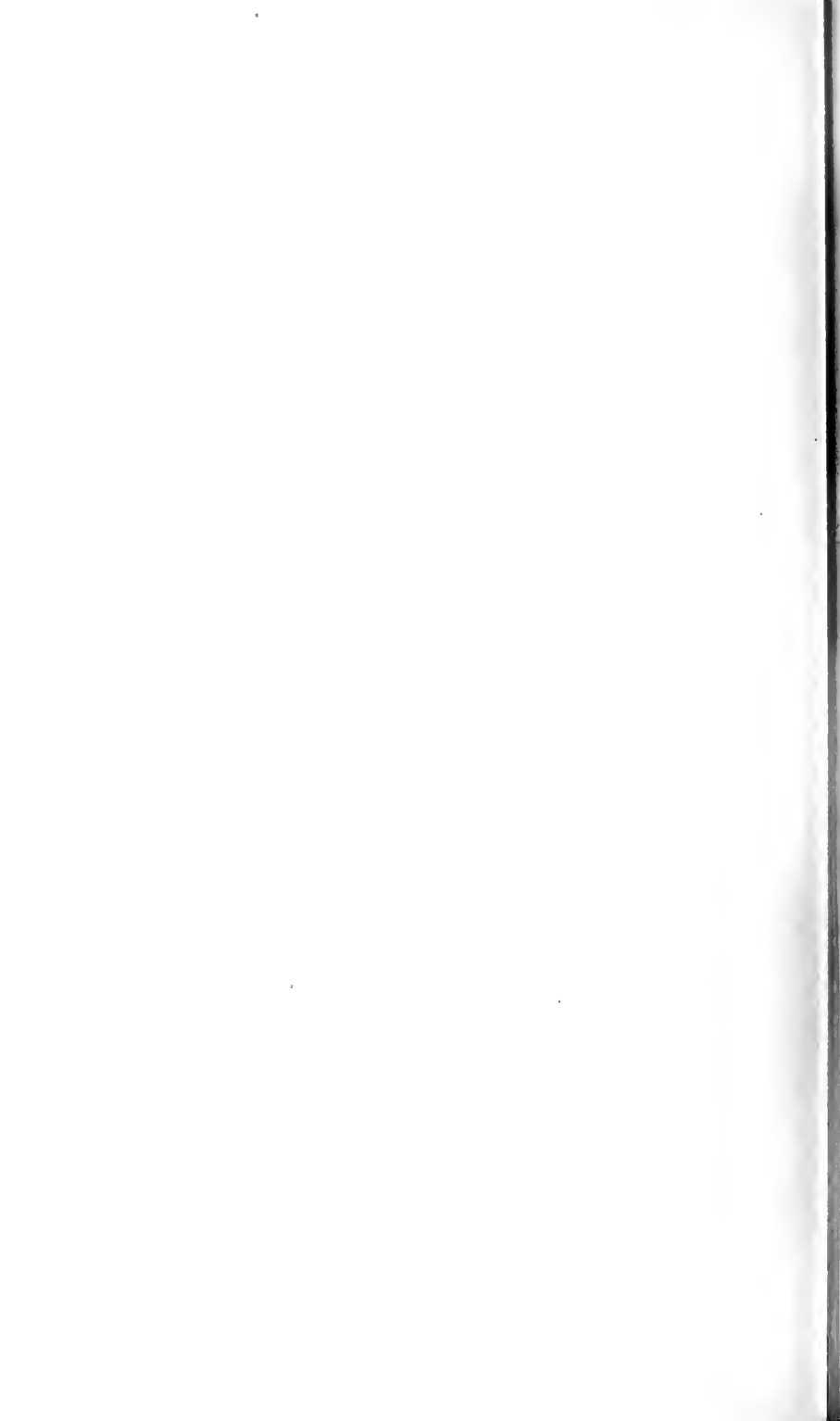




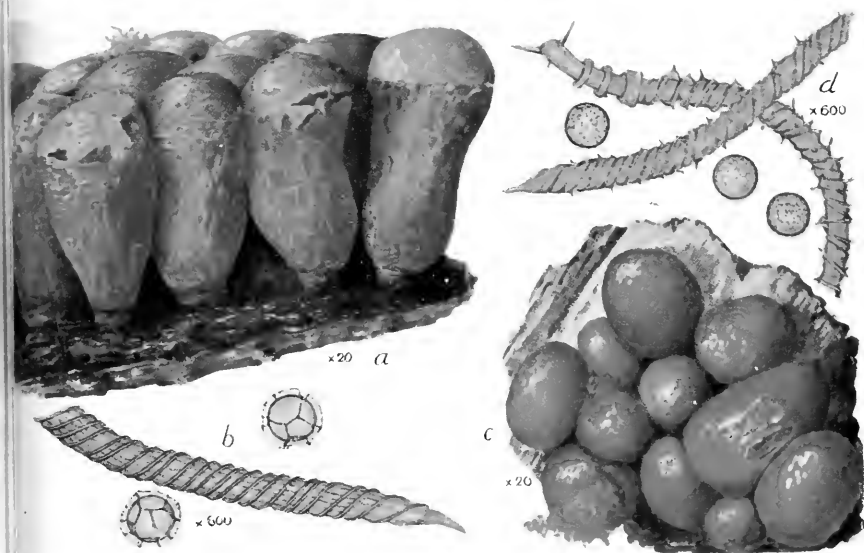
157. LYCOGALA CONICUM Pers.



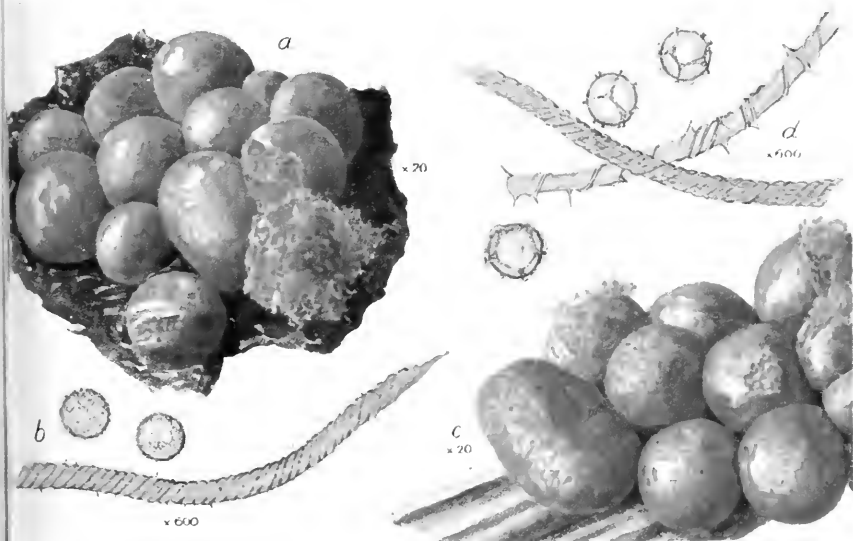
158. a--d, TRICHIA DECIPIENS Macbride;  
e--g, T. ERECTA Rex





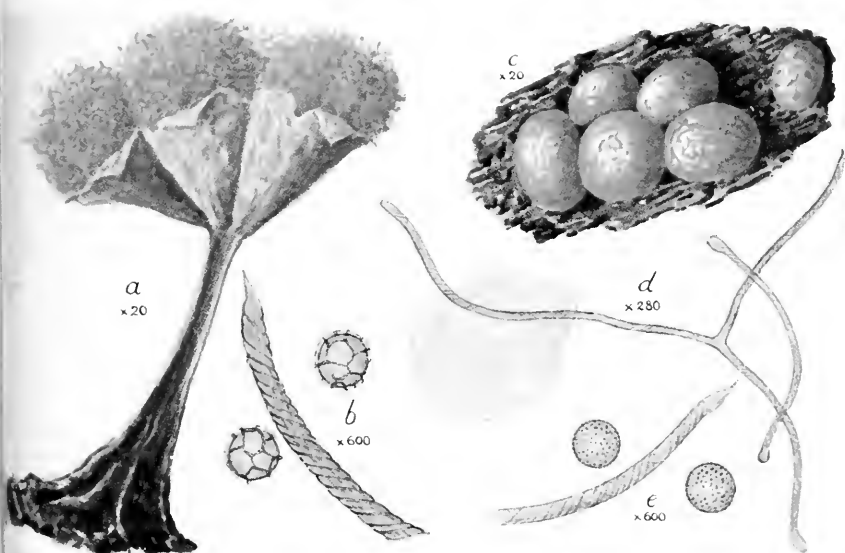
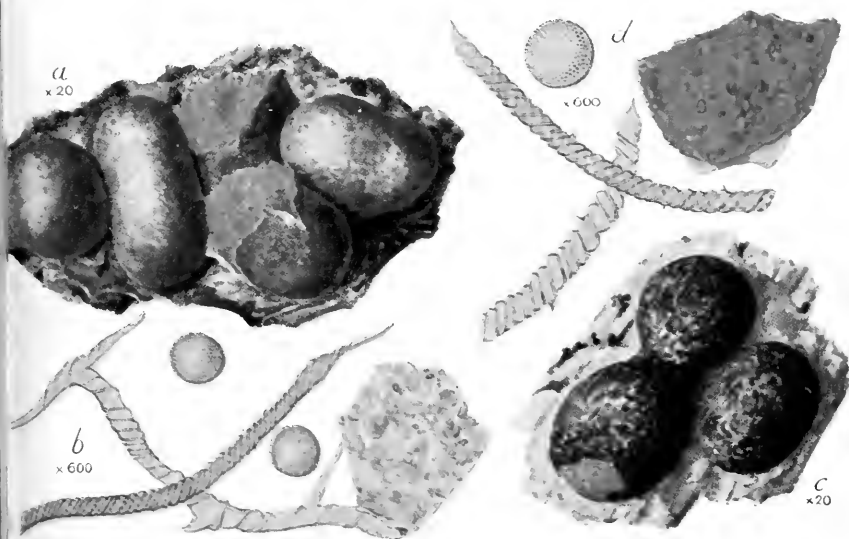


159. *a, b* TRICHIA FAVOGINEA Pers. ;  
*c, d*, T. SCABRA Rost.

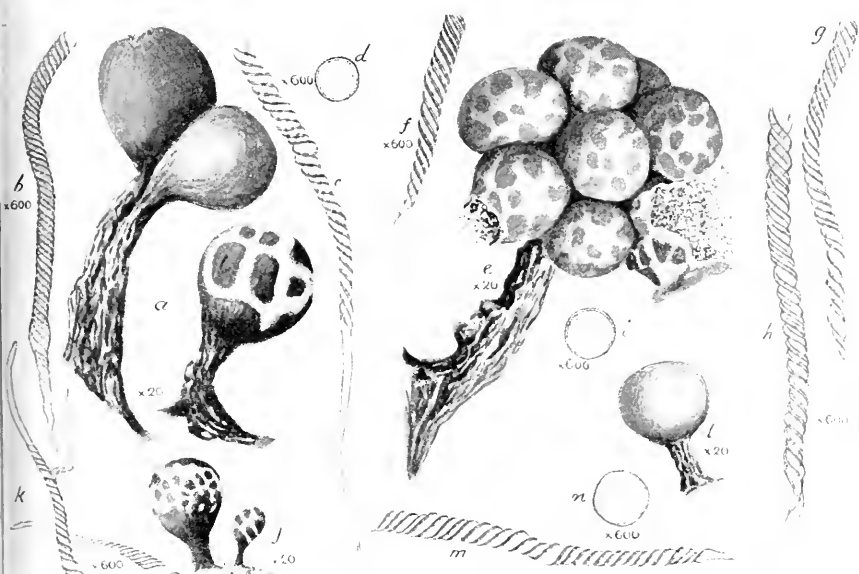


160. *a, b* TRICHIA PERSIMILIS Karsten ;  
*c, d*, T. AFFINIS de Bary

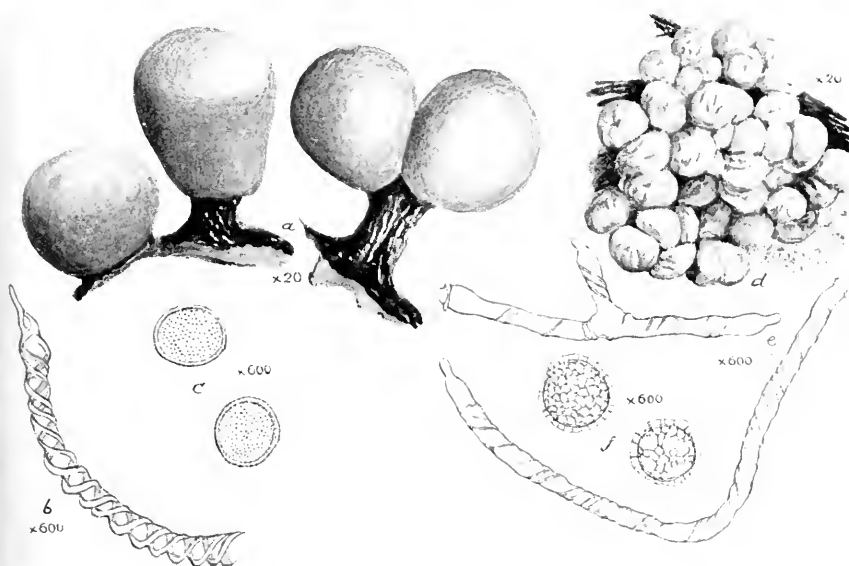


161. c—e, *T. LUTESCENS* Lister162. *TRICHIA CONTORTA* Rost.



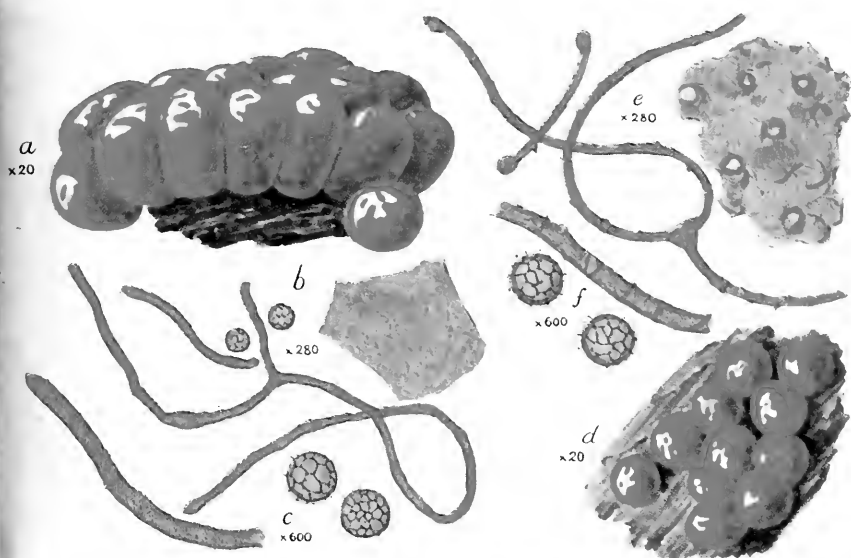


163. *a—k*, *TRICHIA BOTRYTIS* Pers.;  
*l, m*, *T. SUBFUSCA* Rex.

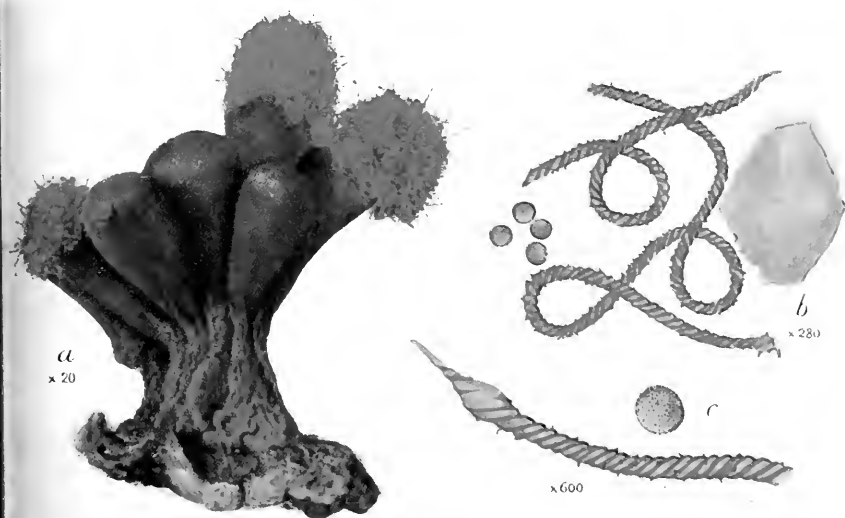


164. *a—c*, *TRICHIA VARIA* Pers.;  
*d—f*, *OLIGONEMA NITENS* Rost.

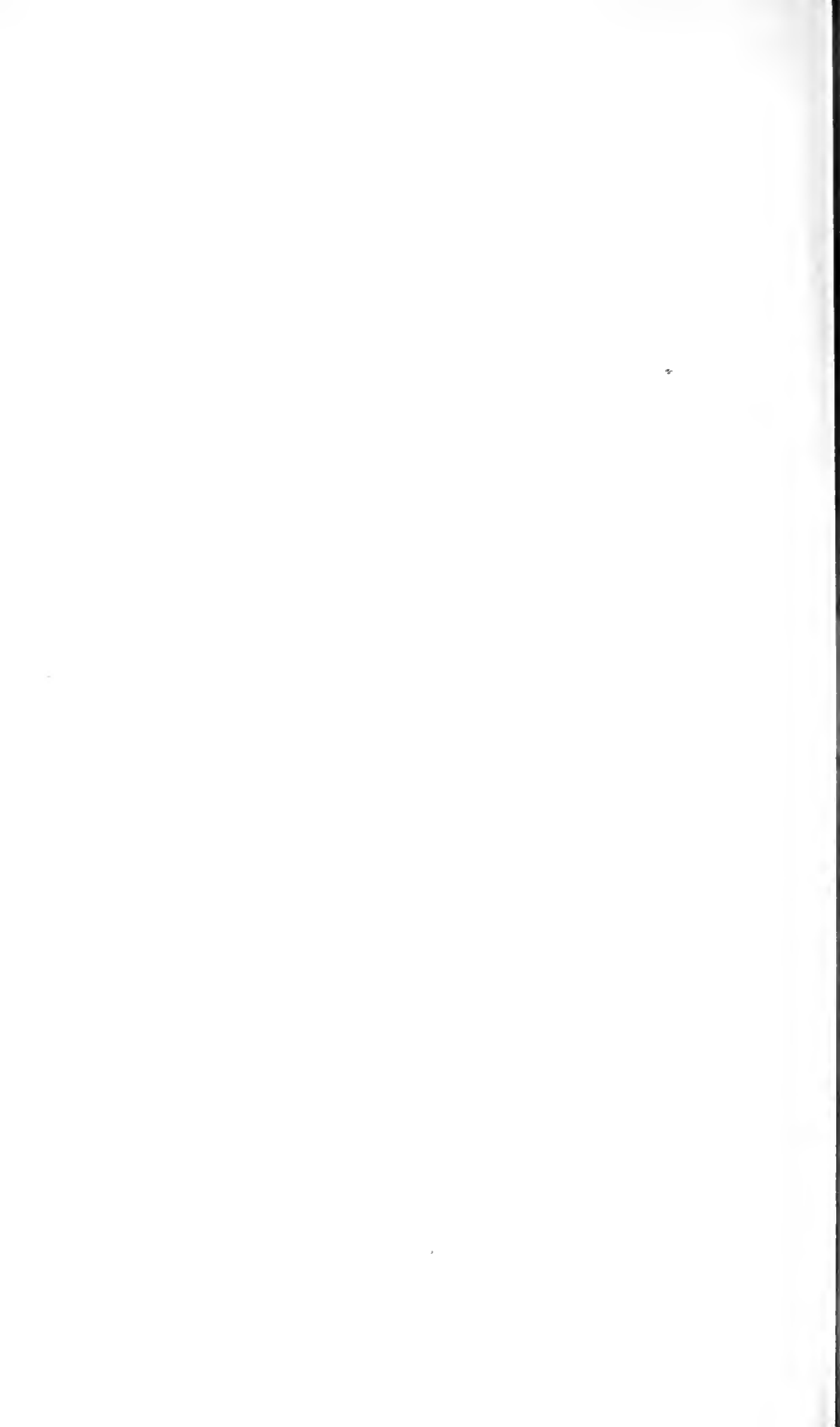




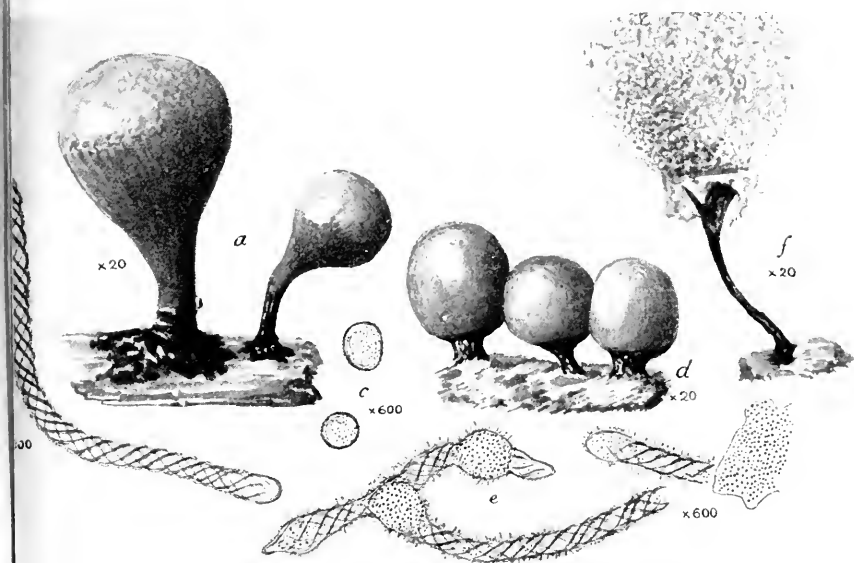
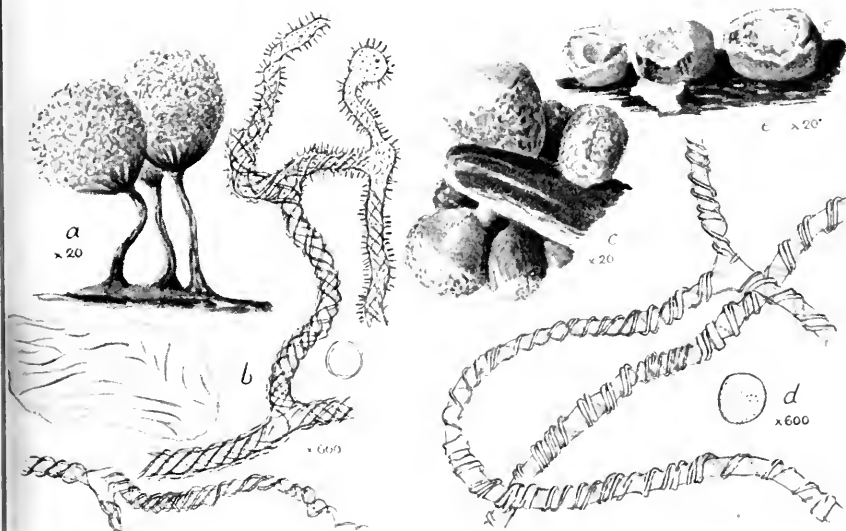
165. *a—c*, OLIGONEMA FLAVIDUM Peck;  
*d—f*, CALONEMA AUREUM Morgan.



166. HEMITRICHIA VESPARIUM Macbr.



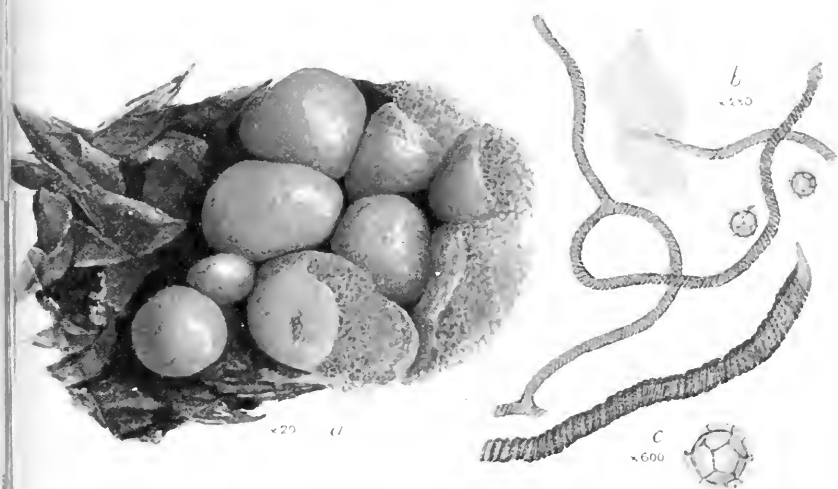
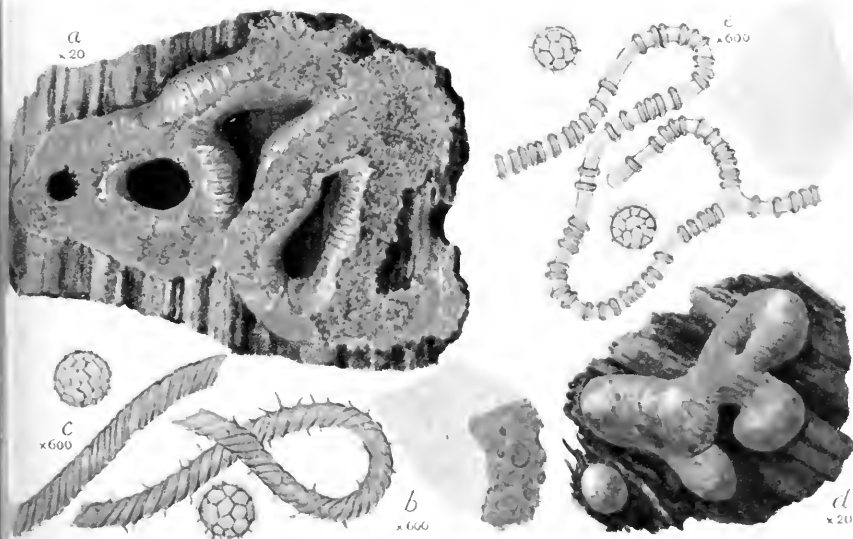


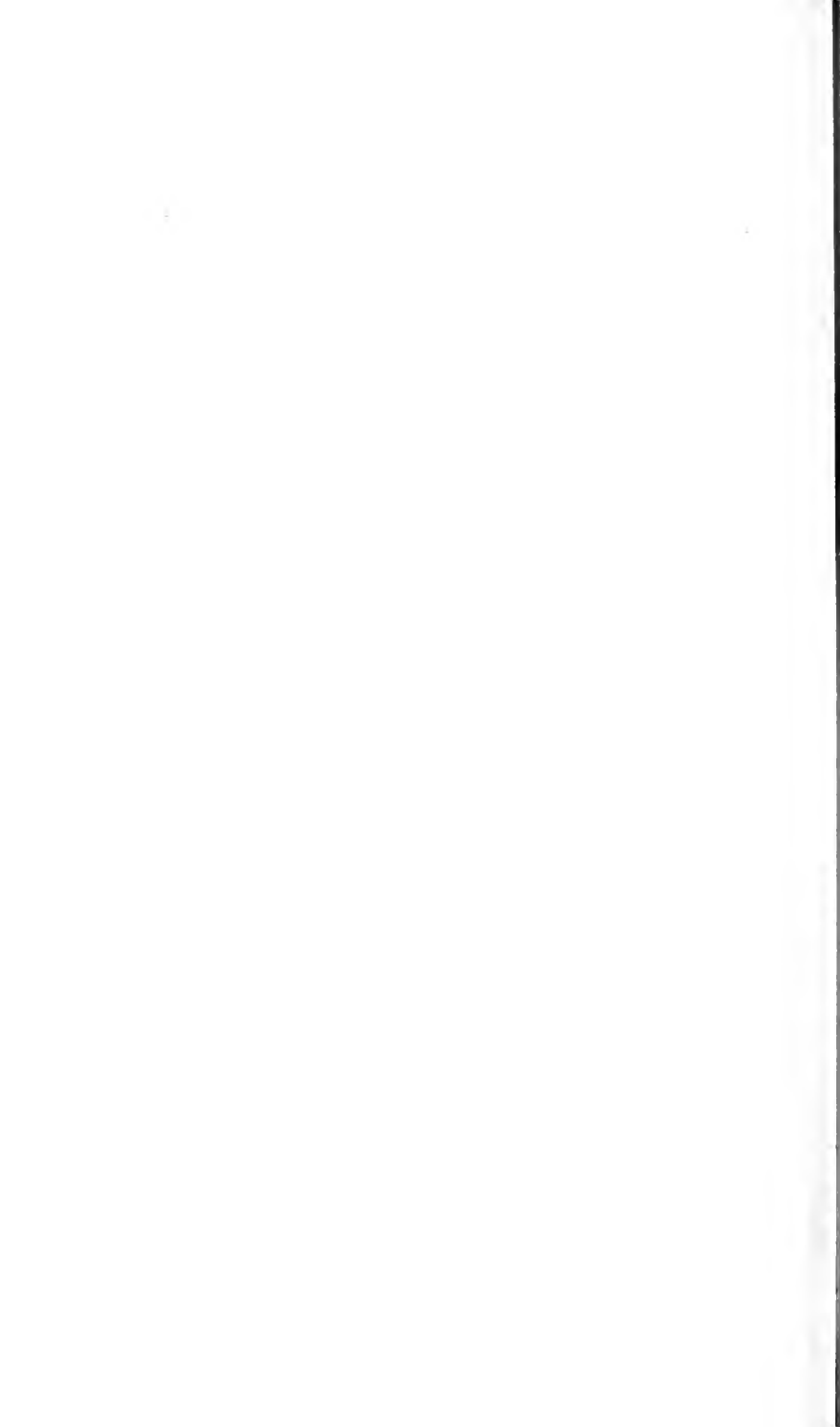
167. *HEMITRICHIA CLAVATA* Rost.168. *a, b, HEMITRICHIA LEOICARPA* Lister ;  
*c—e, H. ABIETINA* Lister

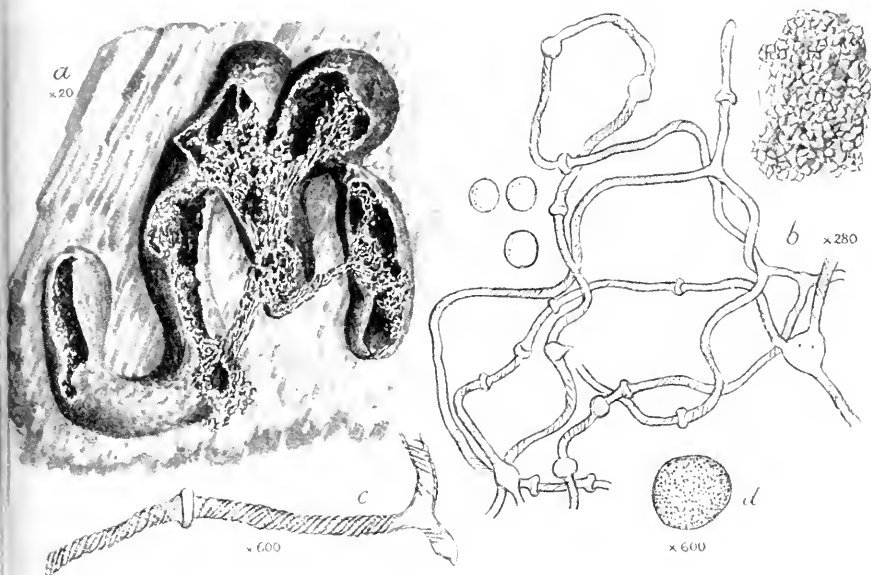
Hemitrichia

Fig. 170 a-c

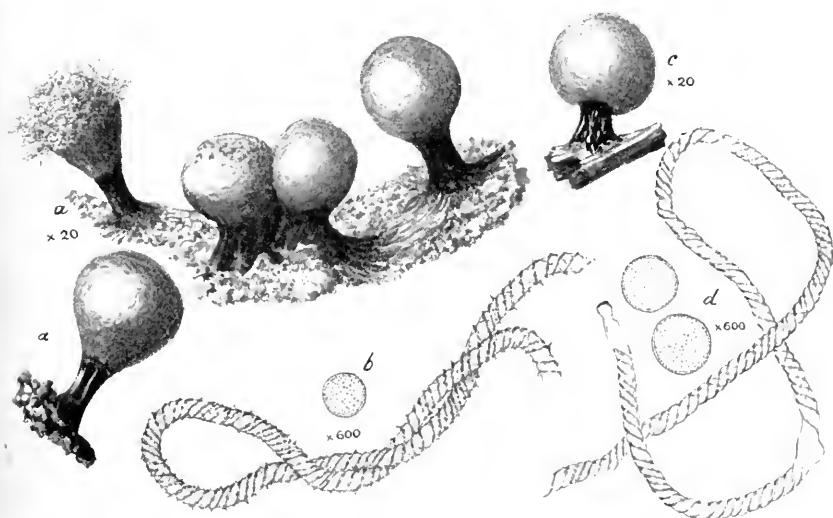
- a. plasmodiocarp
- b. capillitium with  
spiral thickenings
- c. spore

169. *HEMITRICHIA CHRYSOSPORA* Lister170. *a-c*, *HEMITRICHIA SERPULA* Rost.;  
*d, e*, *CORNUVIA SERPULA* Rost.





171. HEMITRICHIA KARSTENII Lister

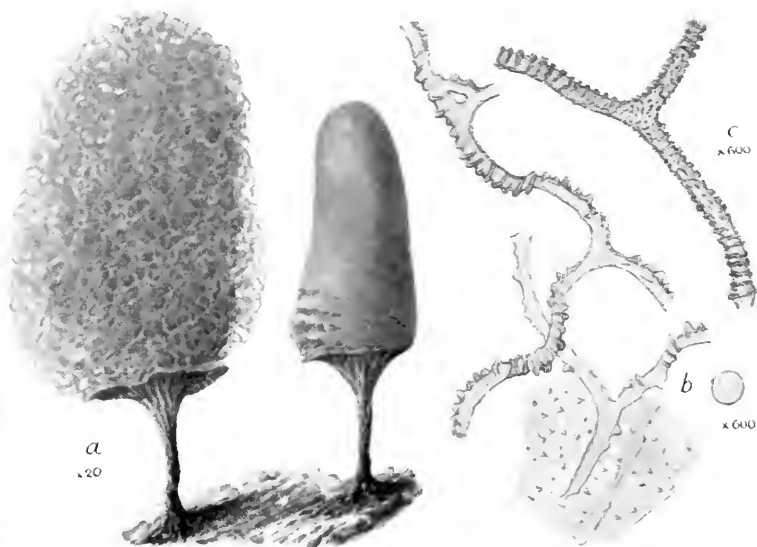


172. c, d, H. LEIOTRICHIA Lister





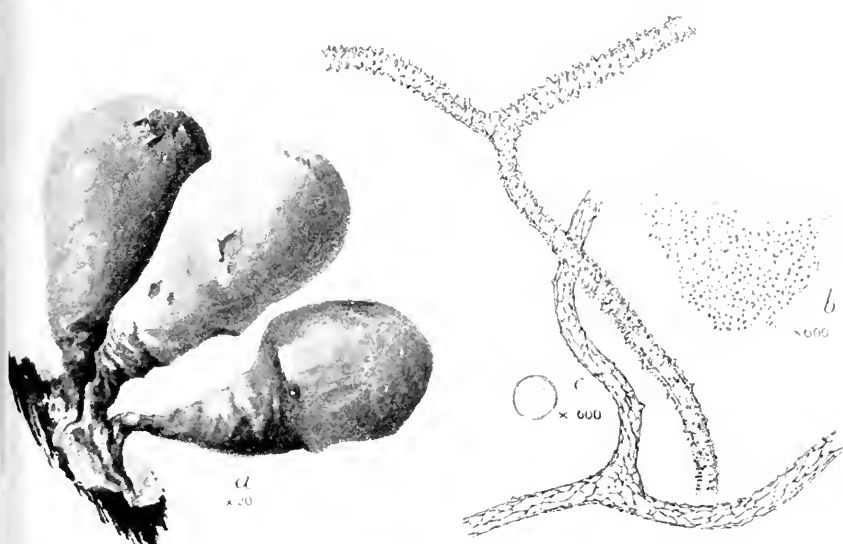
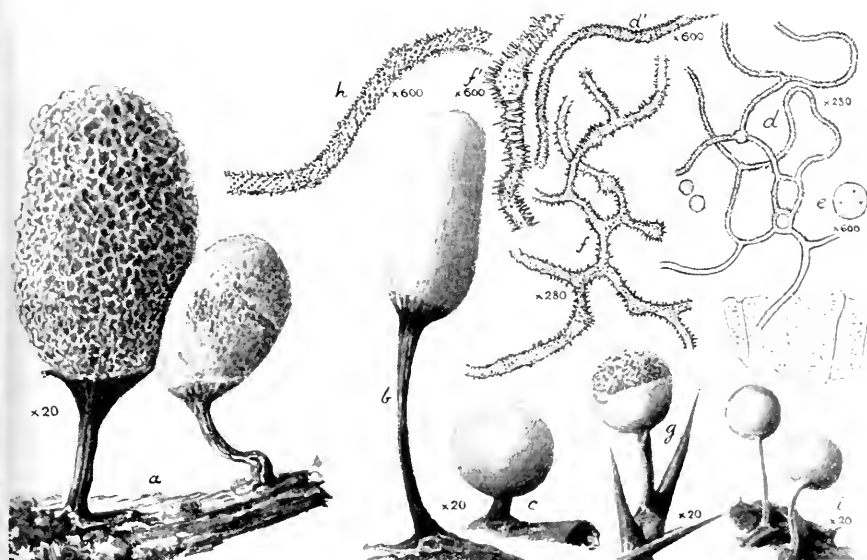
173. ARCYRIA FERRUGINEA Sauter



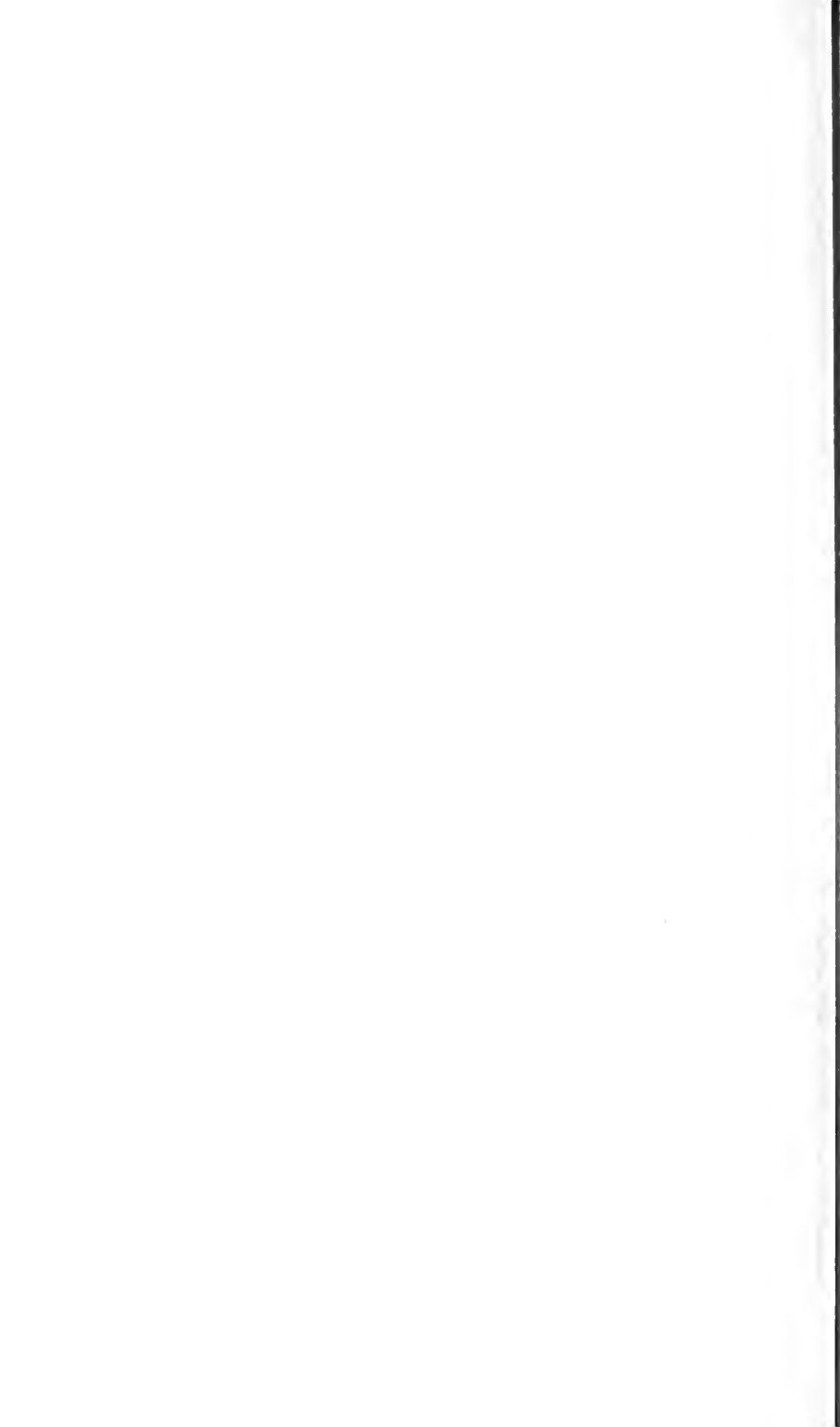
174. ARCYRIA DENUDATA Sheldon

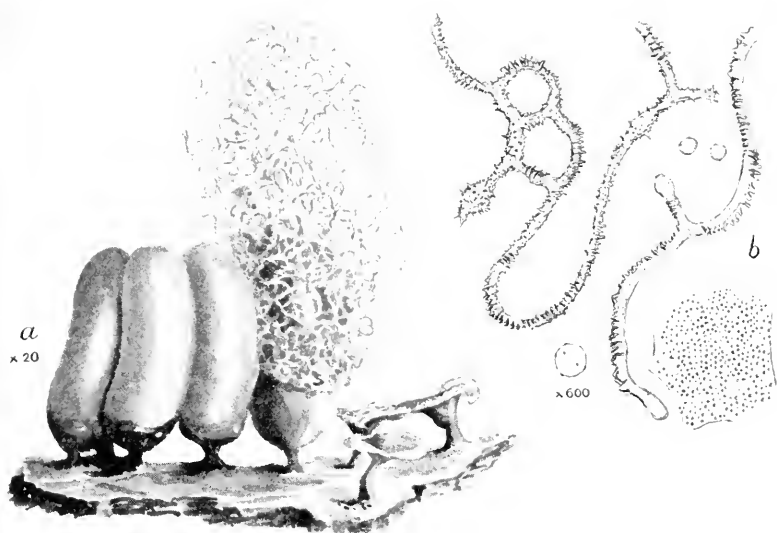




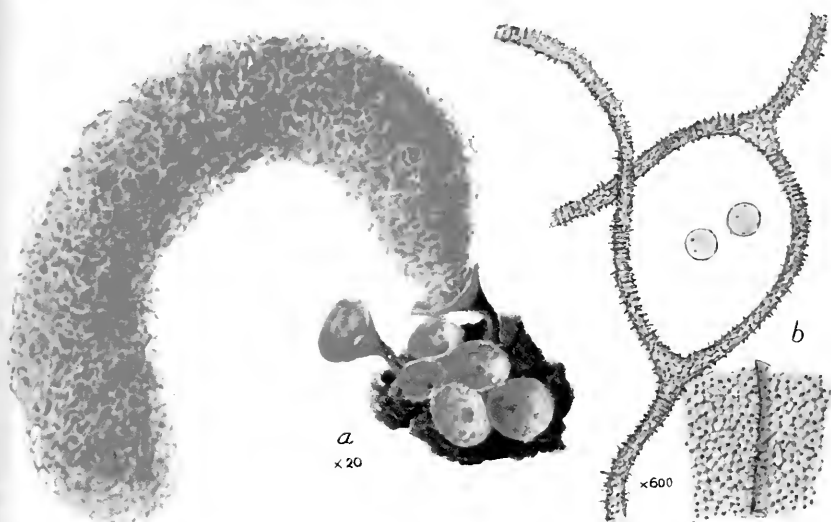
175. *ARCYRIA VERSICOLOR* Phill.

176. *a—e*, *ARCYRIA CINEREA* Pers ;  
*f, f'*, *A. POMIFORMIS* Rost ;  
*g—i*, *A. GLOBOSA* Schwein.

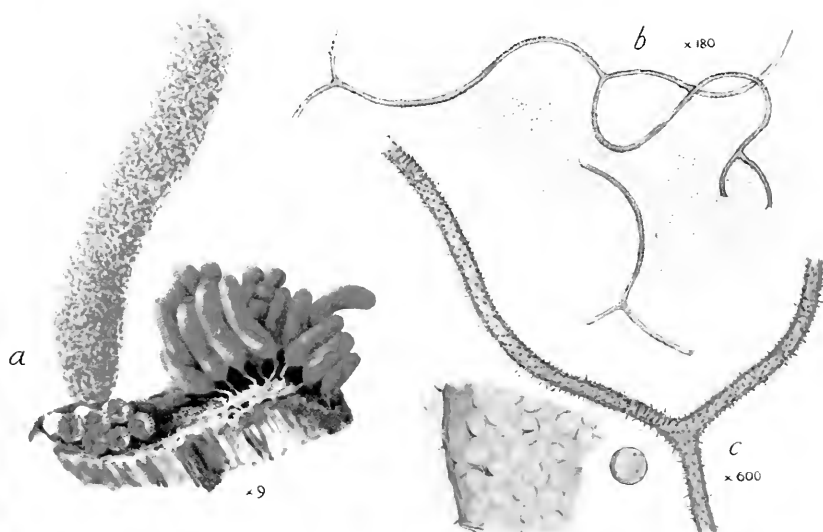


177. *ARCYRIA INCARNATA* Pers.178. *ARCYRIA STIPATA* Lister





179. ARCYRIA NUTANS Grev.

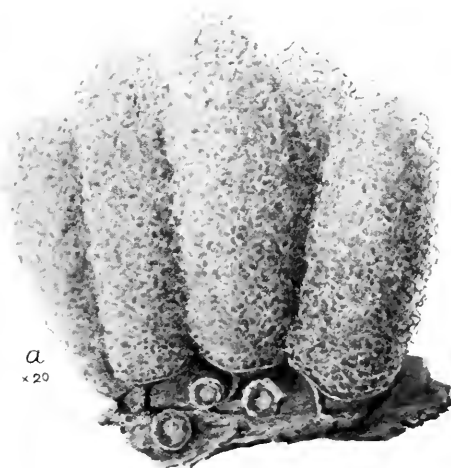


180. ARCYRIA OERSTEDTII Rost.

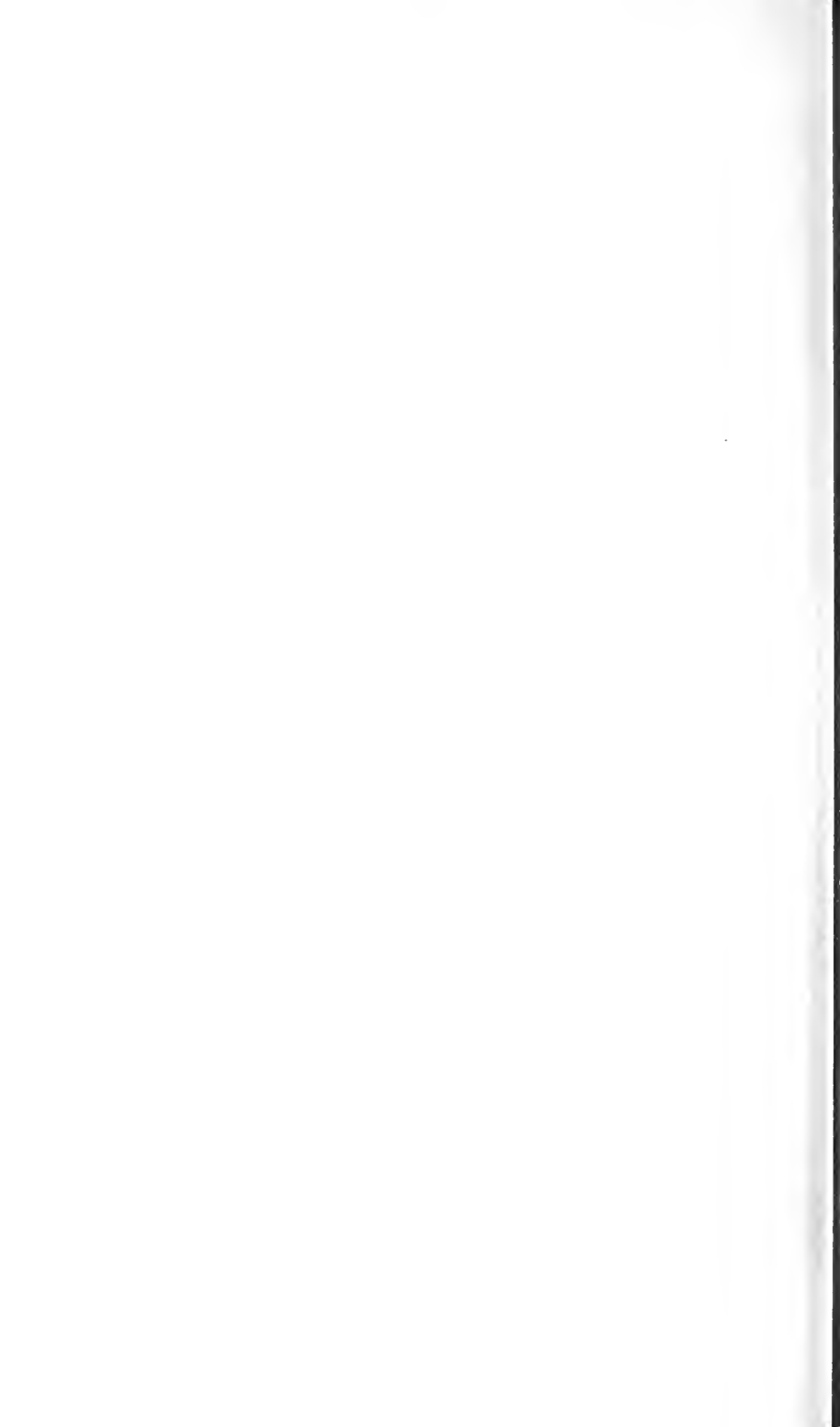




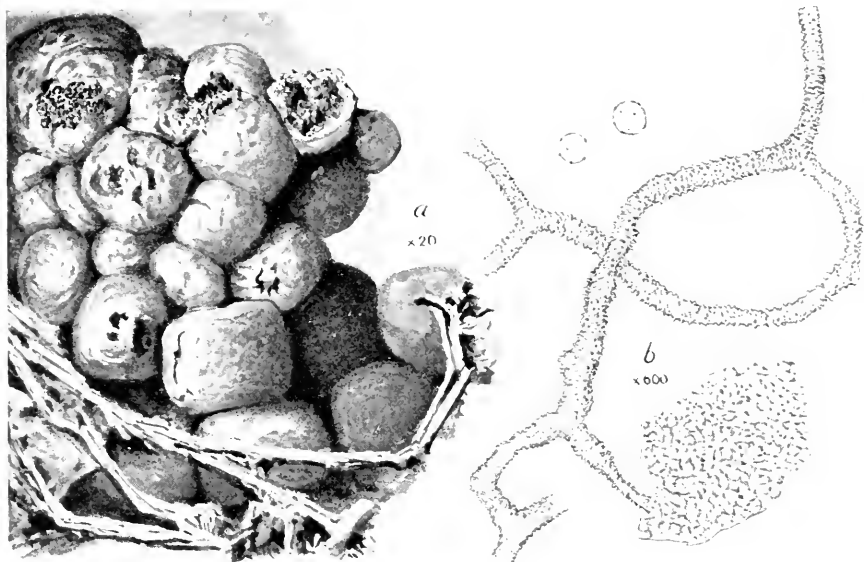
181. ARCYRIA INSIGNIS Kälchbr. &amp; Cooke



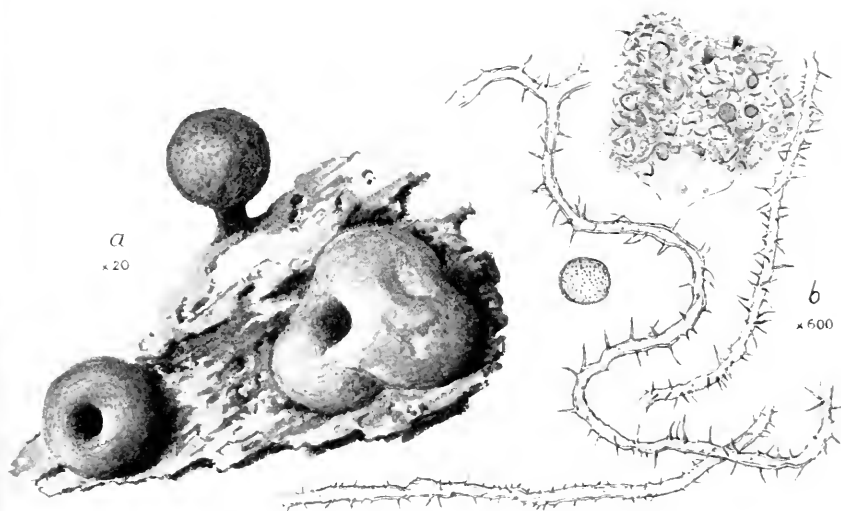
182. ARCYRIA GLAUCA Lister



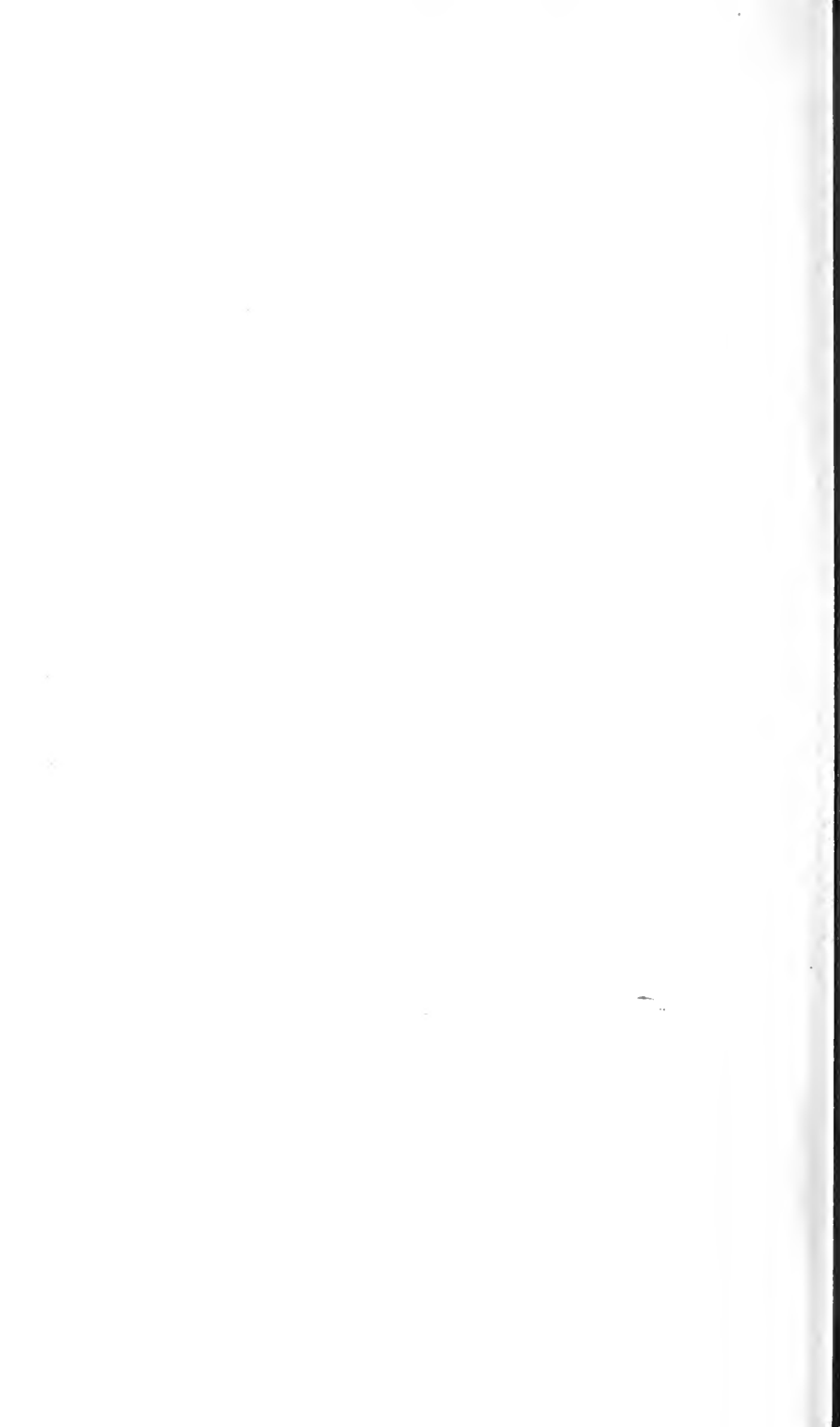


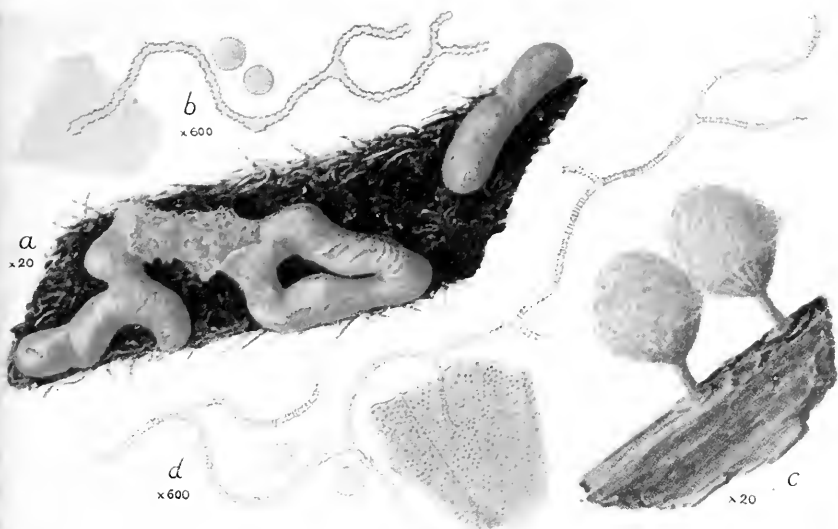


183. LACHNOBOLUS CONGESTUS Lister

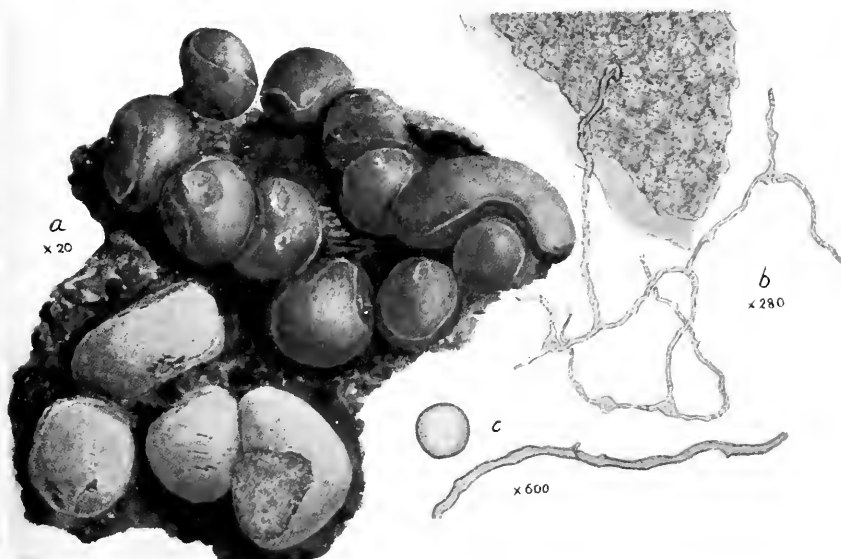


184. PERICHLÆNA CHRYSOSPERMA Lister



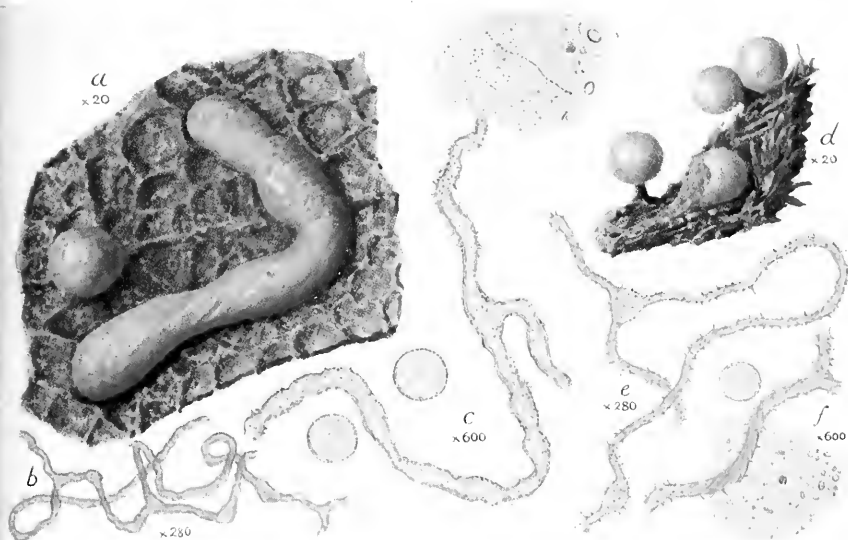


185. *a, b.* *PERICHLENA MICROSPORA* Penzig & Lister  
*c, d.* *ARCYRIA ANNULIFERA* Lister & Torrend

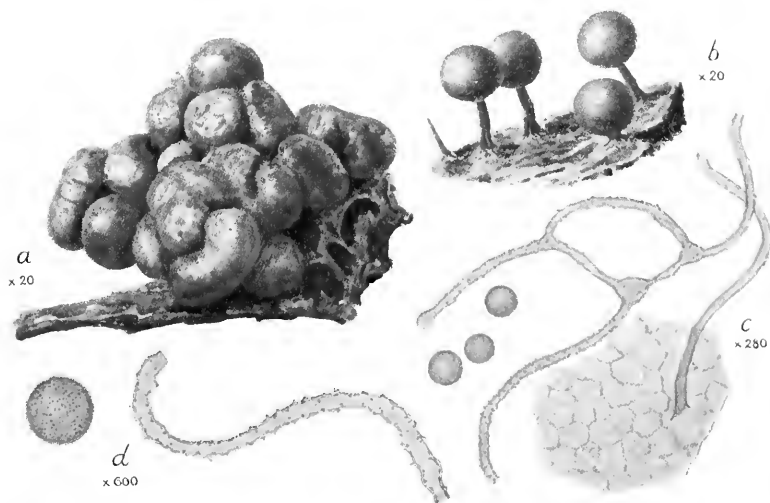


186. *PERICHLENA CORTICALIS* Rost.



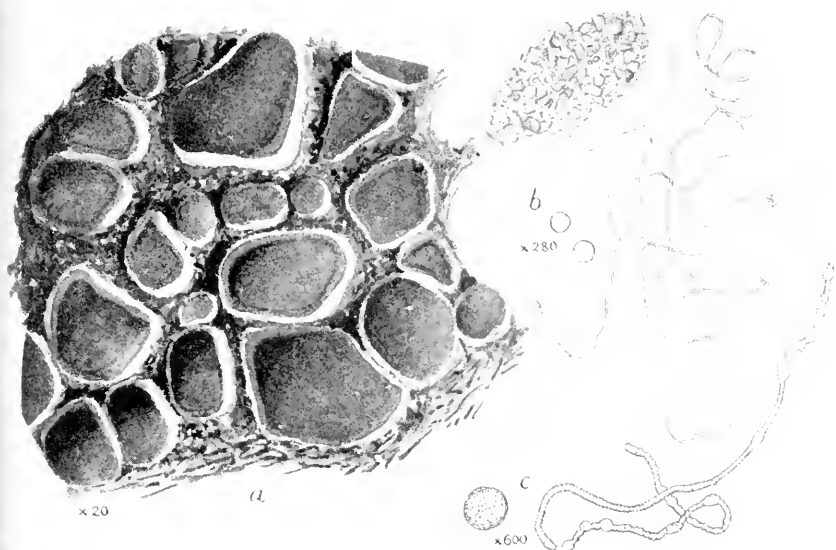


187. *a—c*, *PERICHLENA VERMICULARIS* Rost.  
*d—f*, *HEMITRICHIA MINOR* G. Lister

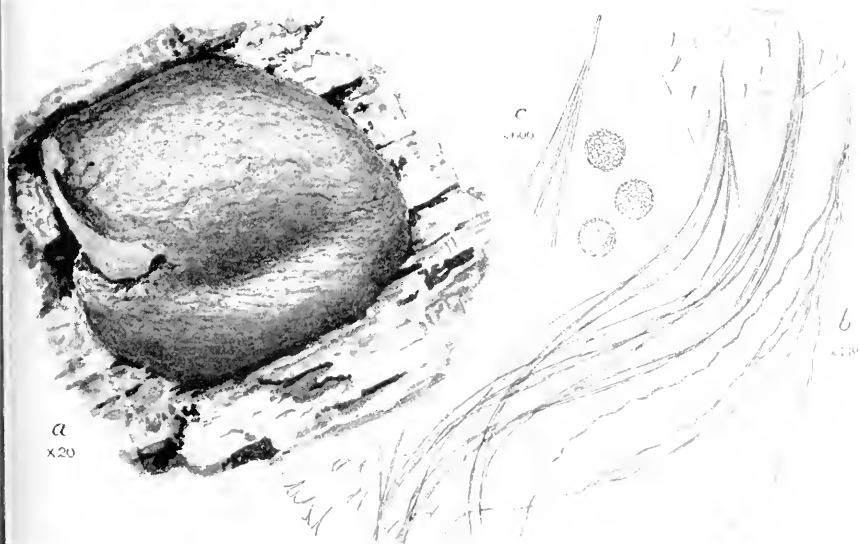


188. *PERICHLENA PULCHERRIMA* Petch





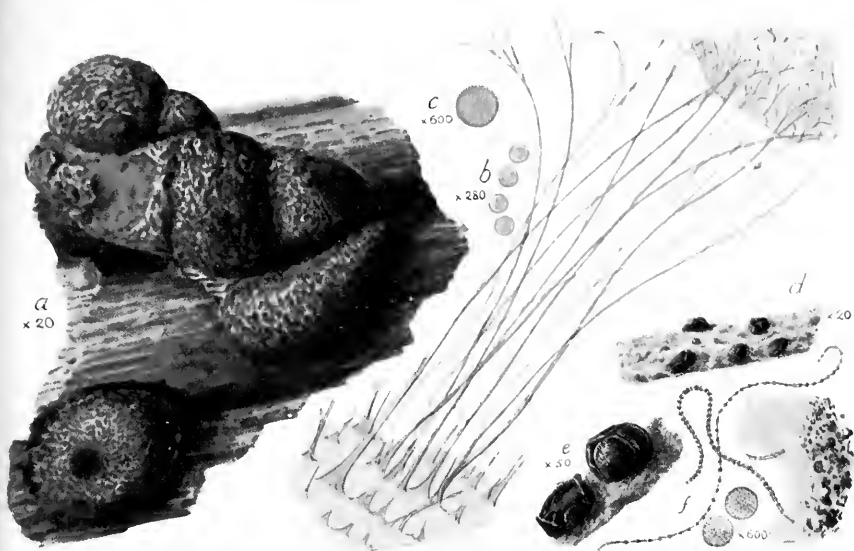
189. PERICHLENA DEPRESSA Libert



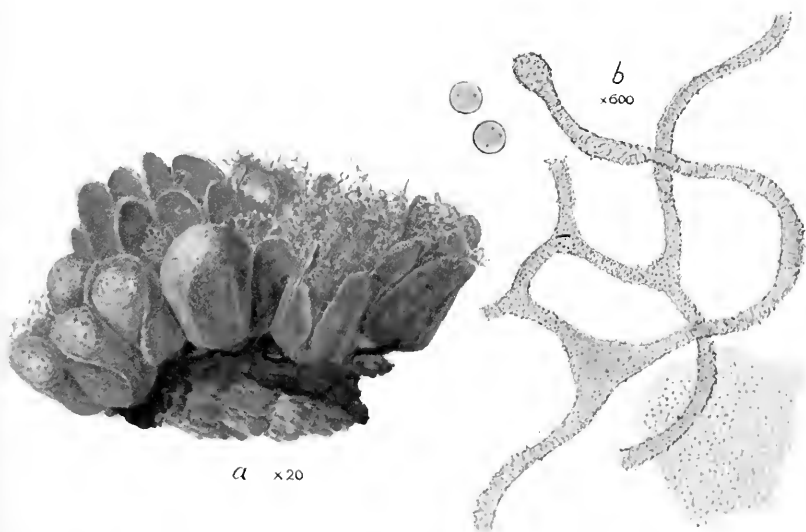
190. DIANEMA DEPRESSUM Lister





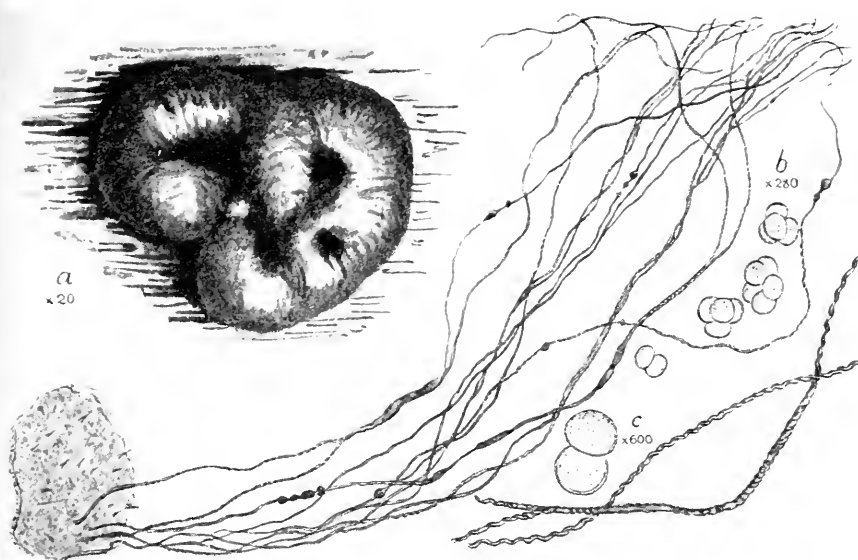


191. *a—c*, *DIANEMA HARVEYI* Rex  
*d—f*, *LISTERELLA PARADOXA* Jahn

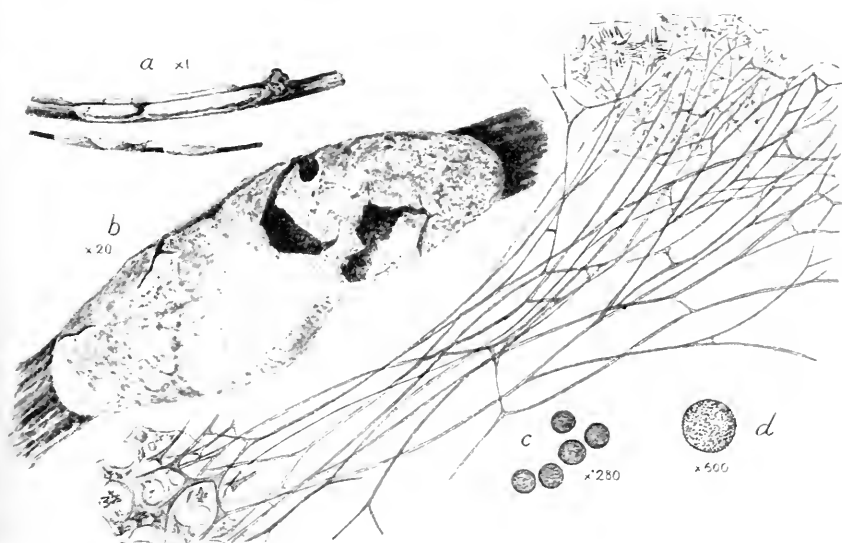


192. *ARCYRIA OCCIDENTALIS* Lister



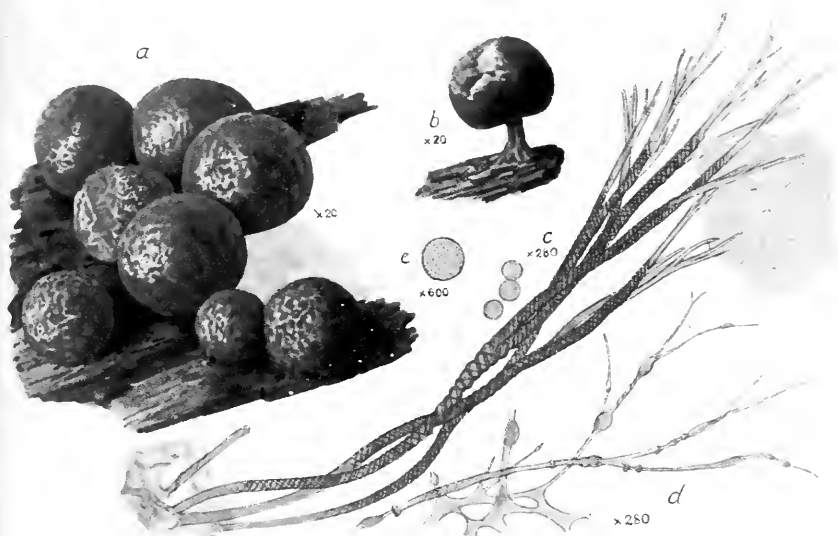
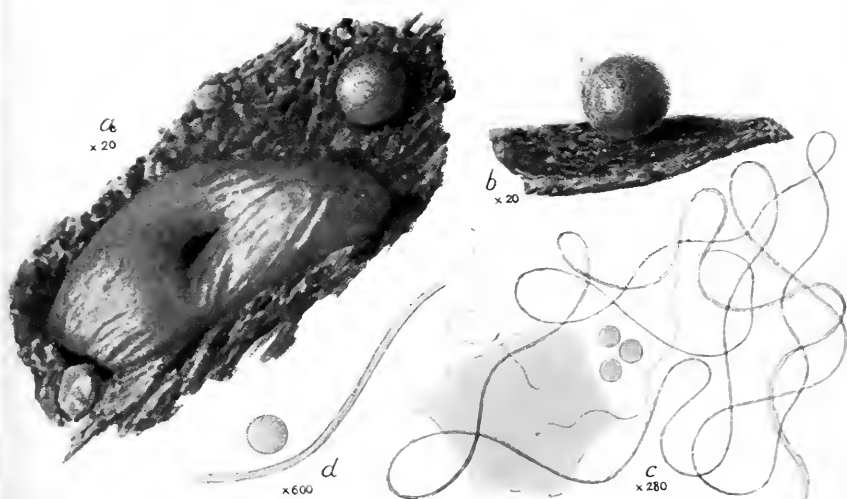


193. DIANEMA CORTICATUM Lister

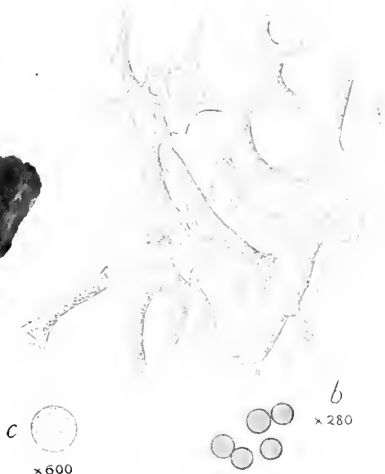
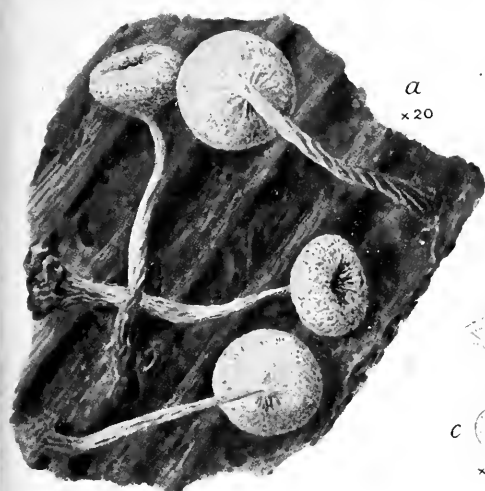
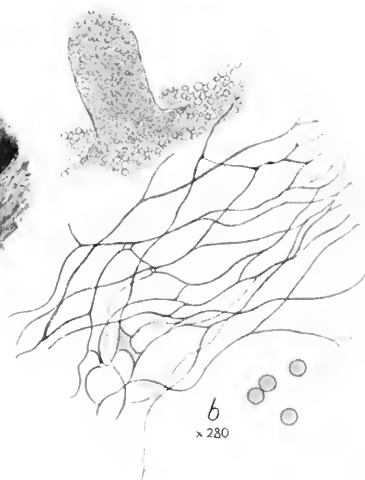
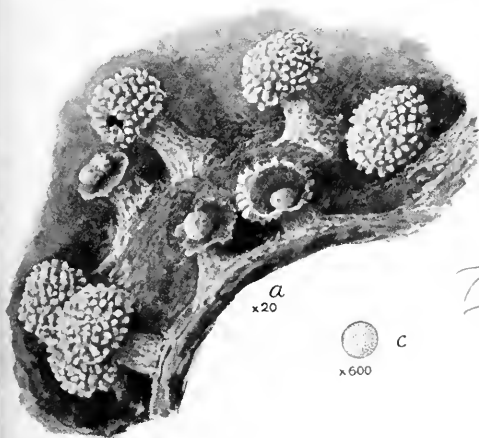


194. DIDYMIUM WILCZEKII Meylan



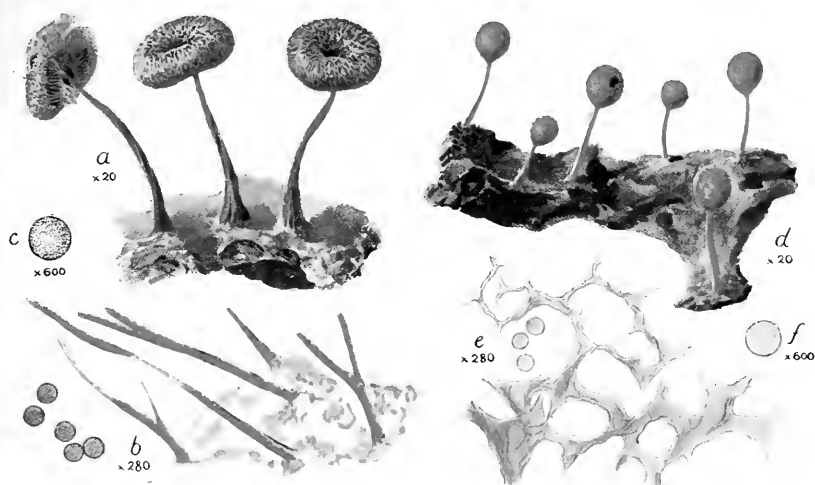
195. *PROTOTRICHIA METALLICA* Mass.196. *MARGARITA METALLICA* Lister



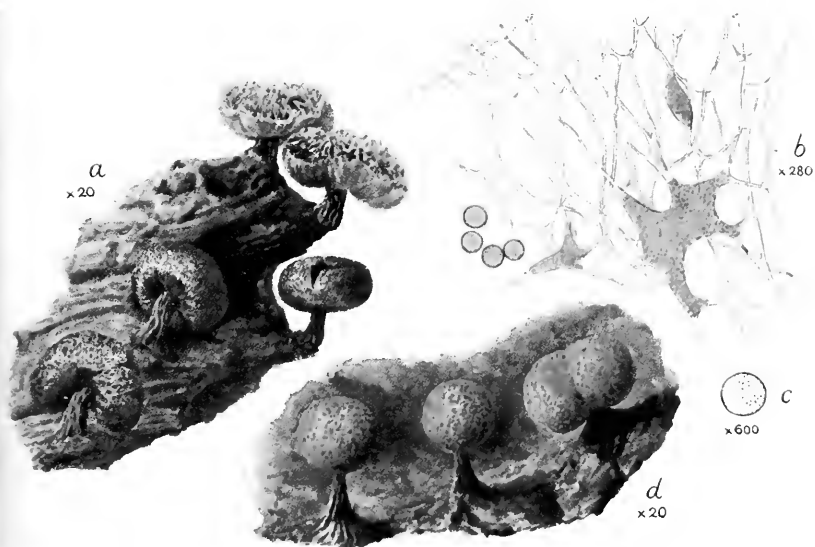
197. *PHYSARUM JAVANICUM* Racib.198. *PHYSARINA ECHINOCEPHALA* v. Höhnelt



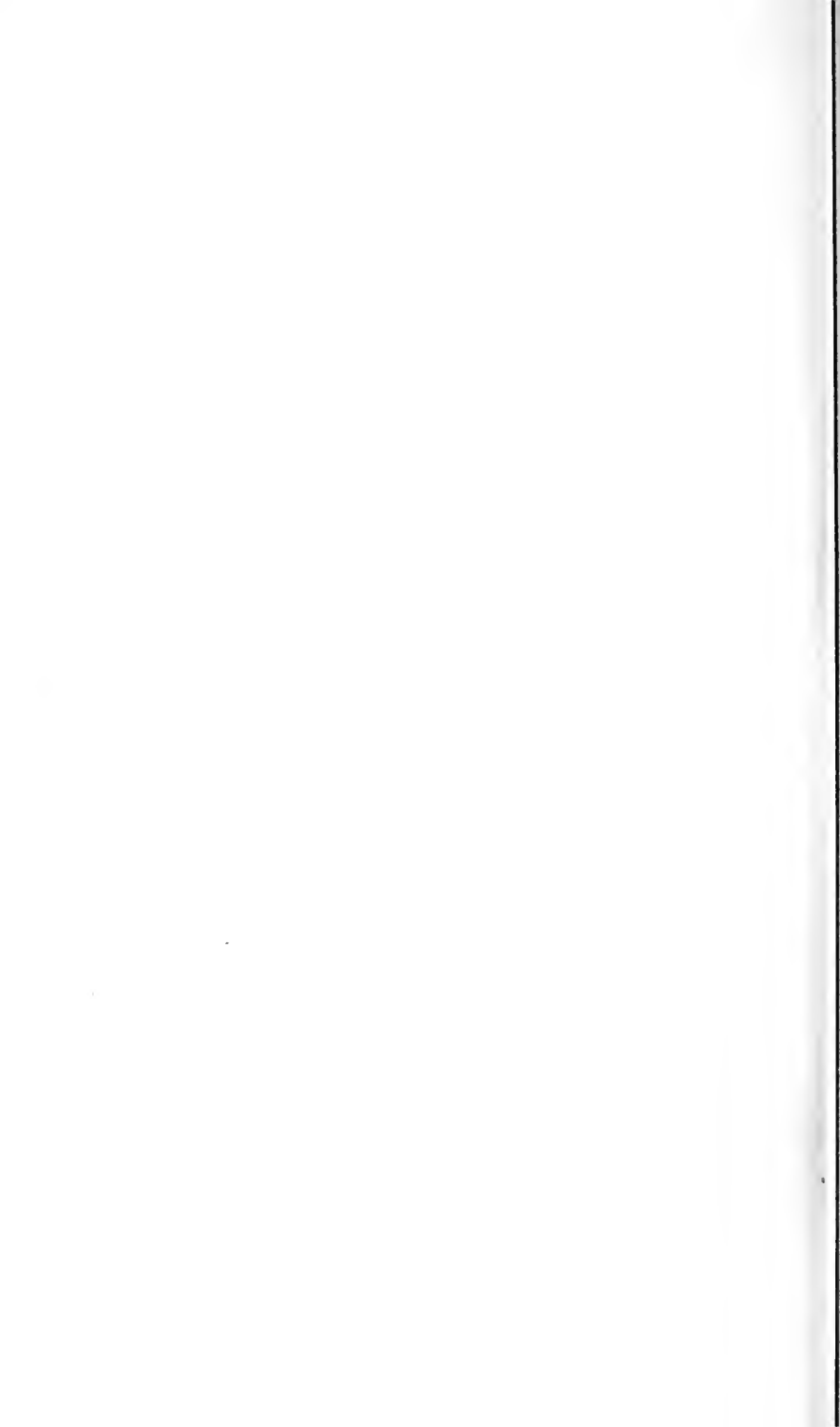




199. a—c, *PHYSARUM VIRIDE* Pers. var. *RIGIDUM* Lister  
 d—f, *P. GALBEUM* Wingate



200. *PHYSARUM BETHELLII* Macbr.



Catalogue of Seals and Whales in the British Museum. By John Edward Gray, F.R.S., &c. 2nd Edition. Pp. vii., 402. 101 Woodcuts. 1866, 8vo. 8s.

— Supplement. By John Edward Gray, F.R.S., &c., Pp. vi., 103. 11 Woodcuts. 1871, 8vo. 2s. 6d.

List of the Specimens of Cetacea in the Zoological Department of the British Museum. By William Henry Flower, LL.D., F.R.S., &c. [With Systematic and Alphabetical Indexes.] Pp. iv., 36. 1885, 8vo. 1s. 6d.

Catalogue of Ruminant Mammalia (*Pecora*, Linnæus) in the British Museum. By John Edward Gray, F.R.S., &c. Pp. viii., 102. 4 Plates. 1872, 8vo. 3s. 6d.

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Catalogue of the Marsupialia and Monotremata in the Collection of the British Museum. By Oldfield Thomas. Pp. xiii., 401. 4 Coloured and 24 plain Plates. [With Systematic and Alphabetical Indexes.] 1888, 8vo. 1l. 8s.

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Cœrebidæ, Tanagridæ, and Icteridæ. By Philip Lutley Selater, M.A., F.R.S. Pp. xvii., 431. Woodcuts and 18 coloured Plates. [With Systematic and Alphabetical Indexes.] 1886, 8vo. 1*l*.

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A Hand-list of the Genera and Species of Birds. [Nomenclator Avium tum Fossilium tum Viventium.] By R. Bowdler Sharpe, LL.D. :—

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Vol. IV. Pp. xii., 391. [With Systematic and Alphabetical Indexes.] 1903, 8vo. 10*s.*

Vol. V. Pp. xx., 678. [With Systematic and Alphabetical Indexes.] 1909, 8vo. £1.

List of the Specimens of Birds in the Collection of the British Museum. By George Robert Gray :—

Part III., Sections III. and IV. Capitonidæ and Picidæ. Pp. 137. [With Index.] 1868, 12mo. 1*s.* 6*d.*

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Catalogue of the Birds of the Tropical Islands of the Pacific Ocean in the Collection of the British Museum. By George Robert Gray, F.L.S., &c. Pp. 72. [With an Alphabetical Index.] 1859, 8vo. 1*s.* 6*d.*

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Index.] 1844, 12mo. 1*s.*

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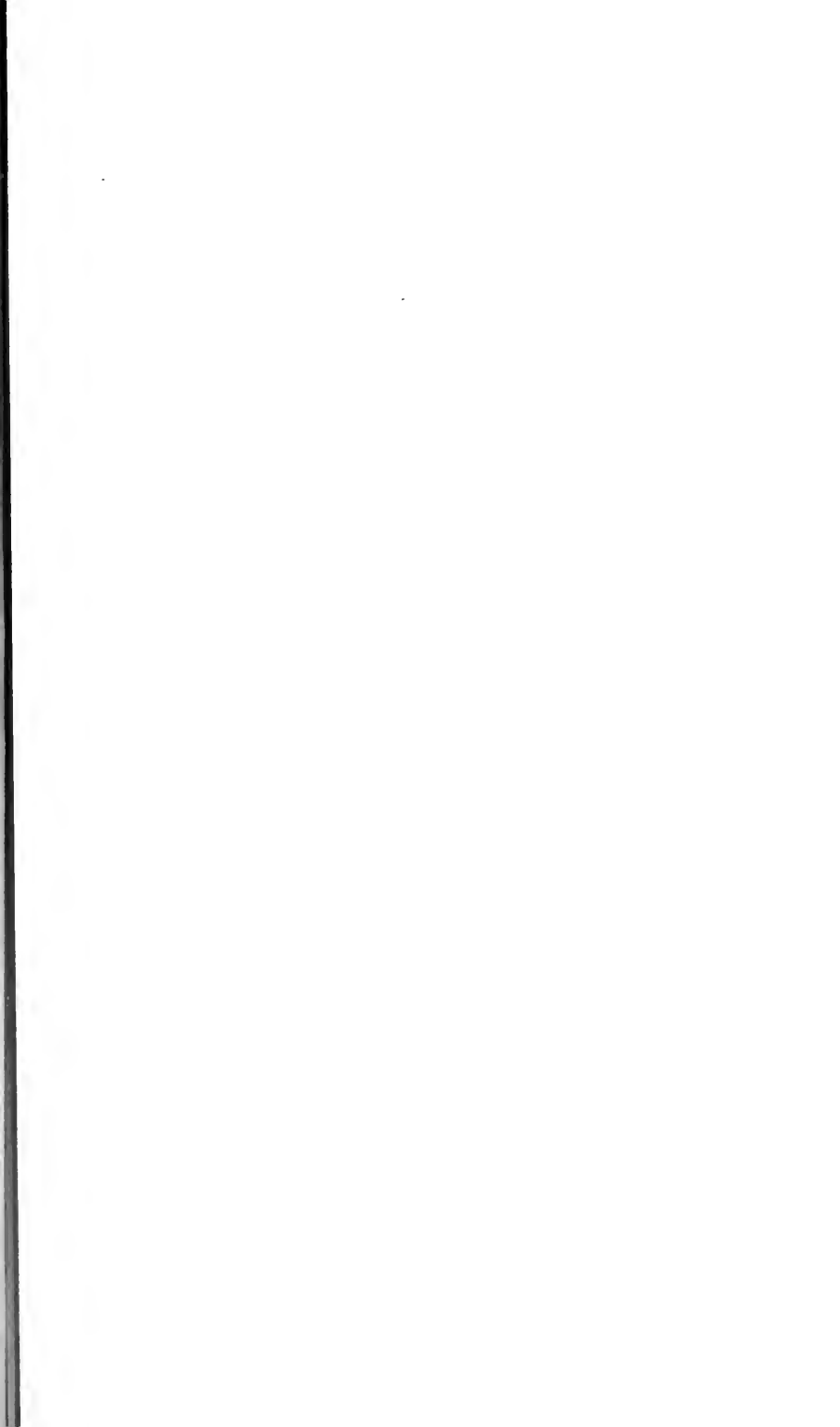
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